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LATE PLEISTOCENE FLORA AT KĄTY (PIENINY MTS., WEST CARPATHIANS)

Późnoplejstoceńska flora z Kątów koło Sromowiec Wyżnich (Pieniny)

ABSTRACT

The Pleistocene flora described from Kąty (Pieniny Mts.) by Dyakowska (1947) has been re-examined by palaeobotanical methods and radiocarbon dating. This investigation aimed mainly at the settlement of the controversy as to the age of this flora, referred to the late period of the Eemian interglacial by some authors and to the Brørup interstadial by others.

It has been found that the fossil flora from Kąty dates from before 51,200 years B. P. (GrN 6251, 6803) and is contained in the profile whose layers belong to the slope — and fluvial deposits characteristic of the terrace of last glaciation age in the Carpathians. This is an interstadial flora. Its known composition and age exclude the interstadials of the last glaciation youger than 50,000 years ago. A comparison with other sites of interstadial florae of this glaciation has led to the conclusion that the Kąty flora comes from the Brørup interstadial.

CONTENTS

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INTRODUCTION

The Late Pleistocene flora from Kąty is generally considered to be interglacial (Horwitz 1963; Szafer 1939; Dyakowska 1947); it is commonly referred to the Eemian interglacial (Klimaszewski 1948; Halicki 1951; Kneblová-Vodičková 1963), although there is also opinion that it is an interstadial flora from the early period of the Vistulian glaciation (Środoń 1952). Several sites of interstadial florae (Brørup, Hengelo) have hitherto been recorded from the Polish Carpathians and their immediate foreland, but no unquestionable Eemian flora is known so far. In this connection the age of the flora from Kąty becomes of essential importance to the Late Pleistocene history of vegetation in the Western Carpathians.

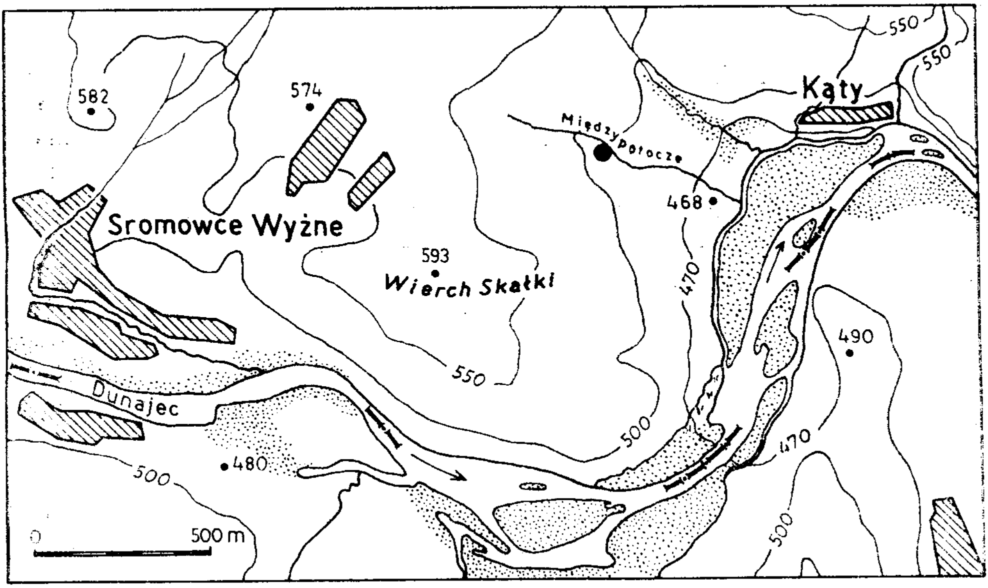
MAIN RESULTS OF PAST STUDIES

L. Horwitz (1963), a geologist, discovered in 1938 a layer of organic sediments in the profile of the middle terrace, cut deep by the valley of the Stream Międzypotocze (Text-fig. 1). The site lies at the opening of the valley, in the place plotted by Horwitz on his geological map of the Pieniny Mts. Horwitz (l.c.) observed that dark blue loams with plant remains overlay a layer of gravels, in which materials from the Tatra Mts., deposited here by the Dunajec River, prevailed.

The profiles elaborated by Dyakowska (1947) *, who used the pollen and macroscopic methods of analysis, represent the sites lying further up the valley, according to Klimaszewski (1948), several hundreds of metres from its opening. Three distinct series of sediments can be distinguished in them, a lower series, consisting of Dunajec gravels and sands of river-bed facies, about 2 m in thickness, a middle

* In her paper A. Środoń was mentioned by mistake among the persons who had taken samples for study at Kąty in 1938 and 1939.

series of terrace and old-river-bed sediments (4·0—4·5 m), composed of alternating layers of peat, loam, clays and sand, and an upper one of solifluctional origin, built of clays and local angular gravels (4·30—7·30 m). The occurrence of the flora-bearing layer at the opening of the valley and in its inside indicates that this layer as well as layer of Dunajec gravels spreads over a fairly large area.



Text-fig. 1. Map showing the situation of the locality (big black dot) from which pollen diagrams are examined

Ryc. 1. Mapa przedstawiająca położenie stanowiska (duży czarny punkt), z którego są opracowane diagramy pyłkowe

D y a k o w s k a (1947) placed the flora from Kąty in the late period of an interglacial without defining its age precisely. K l i m a s z e w s k i (1948, 1952) was the first to assume a trenchant attitude towards this problem; taking for granted that the fossil flora occurs merely in the upper part of the valley, he recognized the gravels situated at the bottom as fluvioglacial deposits of the Saalian glaciation, separated by a formation of the Eemian interglacial from the solifluctional mantle of last glaciation age. H a l i c k i (1951), basing himself on the results obtained by D y a k o w s k a (l.c.), also referred the organogenic sediments from Kąty to the late phases of the Eemian interglacial. In revising the Carpathian Pleistocene florae a year later, Ś r o d o ń (1952) included the flora from Kąty to the Brørup interstadial. A detailed justification of this conception is given in a paper by B i r k e n m a j e r and Ś r o d o ń (1960). S z a f e r (1953), did not share this opinion, nor did K n e b l o v á - V o d i č k o v á (1963), who called it in question on account of the resemblance of the pollen diagram from Kąty to the final section of the diagram representing Eemian travertines from Gánovce near Poprad in Slovakia.

RESULTS OF PRESENT STUDY

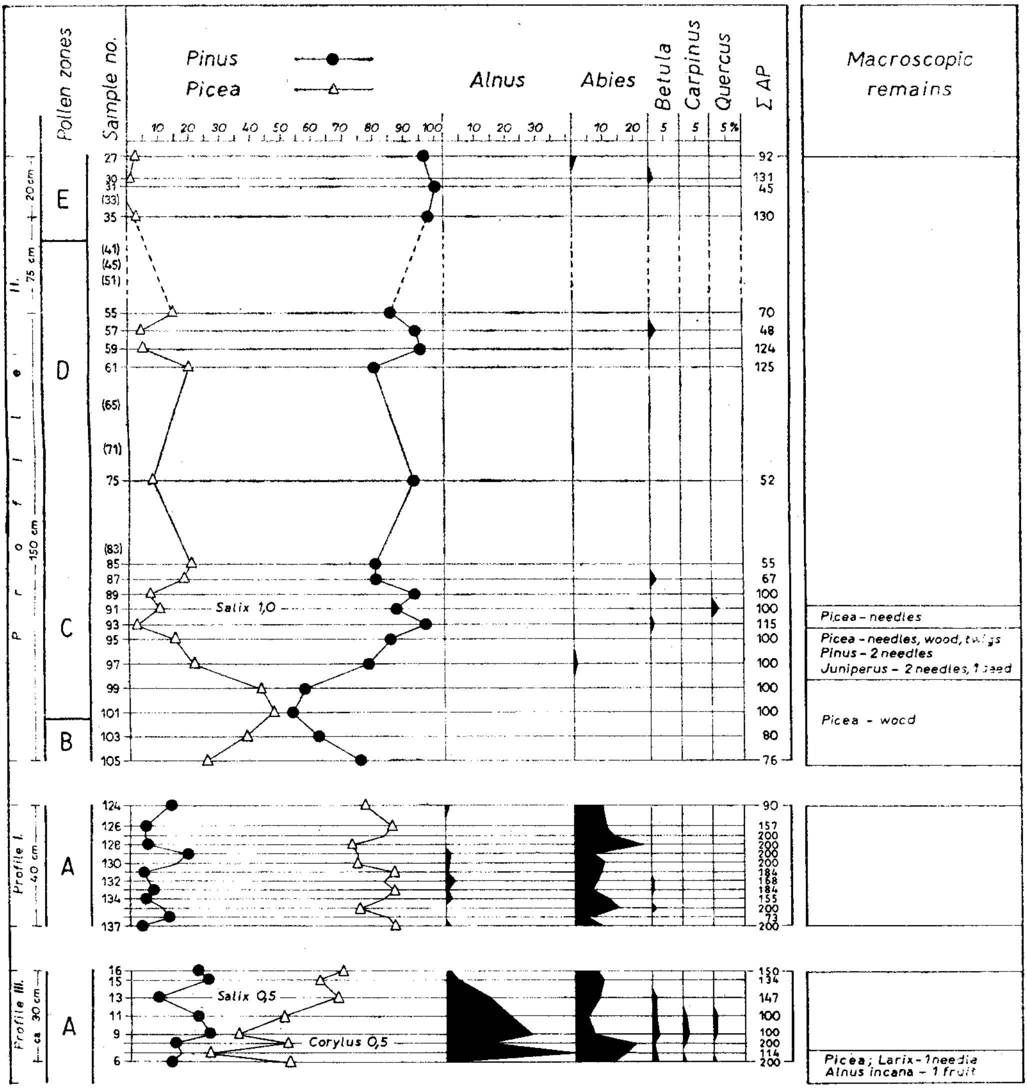
These differences in opinion concerning the age of the Kąty flora prompted its re-examination. The profiles studied palinologically by D y a k o w s k a (1947) and embracing three different episodes of vegetational history, were combined by her into a successive whole on the basis of the correlation of sections with similar pollen pictures (Text-fig. 2). Such a combination leaves some room for doubt whether the picture obtained really represents the successive stages of the development of vegetation of the same period. Another point that inclined us to resume this study was the nature of the pollen diagrams obtained from three different profiles; it did not exclude the possibility of finding a profile containing the section preceding the phase of spruce-fir forests with a great proportion of the alder and traces of thermophilous trees. The discovery of this older section of vegetational history at Kąty might provide information of decisive importance to the determination of the age of this flora. The study initiated in 1969 was, in addition, designed to furnish us with material for radiocarbon dating.

SITE AND STRATIGRAPHY

The profiles examined in the present study are those of the exposures obtained in excavations in the right-hand slope of the valley of the Stream Międzypotocze at a distance of about 260 m from its opening. They are probably situated in the neighbourhood of the profiles studied by D y a k o w s k a (1947). In both newly unearthed profiles the bottom of organic sediments is placed at an altitude of 490 m a.s.l.

The profile Kąty I was uncovered in the lowest part of the slope in 1969 and the profile Kąty II, uncovered two years later, is situated in the immediate vinicity of profile I. Here the exposure cuts about 1·50 m deeper into the slope and, in consequence, the profile Kąty II includes a considerable portion of solifluctional sediments in the top part. In the course of study this profile appeared to comprise all the three sections investigated by D y a k o w s k a (l.c.).

Profile I was examined by the methods of both pollen and macro-



Text-fig. 2. Kąty near Sromowce Wyżnie. Three pollen diagrams studied by Dyakowska (1947), arranged in stratigraphical order

Ryc. 2. Kąty koło Sromowiec Wyżnich. Trzy diagramy pyłkowe opracowane przez Dyakowską (1947), zestawione w następstwie stratygraficznym

scopic analyses. The correlation of samples is given in Text-fig. 3. Wood pieces of *Alnus* sp. used for radiocarbon dating were taken from the upper part of the organic mud in this profile (1·25—1·30 m).

Profile II was mainly examined by the pollen analysis. Macroscopic remains of plants used for identification were derived only from the horizon of 2·40—2·50 m. Part of the material collected for ^{14}C dating, was used for this purpose.

The stratigraphy of the profiles presents itself as follows:

K ą t y I

Depth measured
from surface,
in m

0·00—0·20 — Light yellow topsoil with ingrown roots. Angular sandstones and calcareous gravels frequent, calcareous gravels being finer than sandstones.

0·20—0·40 — Dark grey silty clay with small pieces of wood and charcoal.

0·40—1·00 — Light grey silty clay with very numerous small pieces of wood and charcoal.

1·00—1·20 — Light grey sandy silt abounding in small pieces of wood; charcoals only in upper part of layer.

1·20—1·55 — Highly organic dark brown mud with very numerous big pieces of wood *(Picea, Alnus)*, some of them being compressed.

1·55—1·60 — Slightly organic light brown mud.

Below 1·60 — Sand (not measured) and underlying river gravels.

K ą t y II

0·00—0·60 — Light yellow topsoil with ingrown roots. Angular sandstones and calcareous gravels frequent, calcareous gravels being finer than sandstones.

0·60—1·50 — Dark yellow silty clay with horizontal grey bands and rusty patches and with scattered single calcareous gravels.

1·50—2·10 — Dark grey silty clay with clumps of fine calcareous gravels and rusty patches.

2·10—2·62 — Dark grey silty clay with sparse fine calcareous gravels. A large number of small pieces of wood and charcoal scattered in disorder. In places small lenses filled with plant remains (chiefly small wood pieces). Band of calcareous gravel at a depth of 2·50 m; bigger fragments of wood and pine cones occur at the same level.

2·62—3·27 — Light grey silty clay with numerous small charcoals scattered in disorder. In the bottom part of the layer there is a more sandy olive-green lens, 15 cm in diameter.

3·27—3·35 — Light grey silty clay with admixture of sand.

3·35—3·55 — Rusty-yellow silty clayey sand, strongly hydrated, with numerous rusty patches and, in top part, thin rusty hard-pan (about 1 cm).

3·55—3·60 — Light grey and rusty laminated silt.

3·60—3·80 — Highly organic dark brown mud with numerous big pieces of wood, some of them being compressed.

3·80—3·87 — Light grey silty clay with small admixture of sand (no wood).

3·87—3·89 — Rusty hard-pan.

3·89—3·99 — Rusty coarse-grained sand.

3·99—4·15 — Rusty sandy river gravels.

A comparison of the sediments of the two profiles show that in spite of their immediate neghbourhood they are differentiated. The thickness of the organic mud with big pieces of wood in profile II is considerably smaller than in profile I and the deposits directly overlying the organic series are, in addition, somewhat different in nature. These differences together with the results of pollen analysis suggest a diversified relief of the fossil old river-bed of the Dunajec. The beginnings of accumulation of the organic series differed in time and most probably were conditioned by the differentiated morphology of the surface of the old river-bed. A comparison of the present results with Dyakowska's (1947) profiles leads to a similar conclusion. The pollen diagram of her profile I (Text-fig. 2) covers only the younger part of the spruce-fir period with small numbers of alder despite the fact that like the profile III it reaches down to the top of the mineral sediments underlying both these profiles.

In both profiles now examined the upper boundry of the organic mud coincides distinctly with the decline of the *Abies* curve (Text-figs. 4, 5). A break in the accumulation of the organic mud was caused by the intensified activity of the river (silty and sandy layers) at first and later by solifluctional processes.

The great similarity of the pollen diagrams in the present study and the easiness of their correlation with Dyakowska's (l.c.) diagrams prove that the results of pollen analysis concern the same period in all cases. It seems hardly probable that there was a long interval between the organic mud and the accumulation of the overlying layers.

A similar trend of the spruce and pine curves starting from the level reached by the rapid growth of this last (Kąty I, II and Dyakowska's profile II), indicates that the process of creeping of solifluctional material occurred without any great disturbances in the places examined and thus the results of pollen analysis cannot be called in question from this point of view.

SAMPLE PREPARATION AND MICROFOSSIL ANALYSIS

When this re-examination of the Kąty flora by the pollen analytical method was being undertaken, it was expected that the use of modern laboratory techniques would make it possible to increase the frequency considerably in relation to that obtained by Dyakowska (1947), i.e. 0·5—8 grains per sq.cm.

All the samples were boiled in KOH and next treated with the hot hydrofluoric acid and followed by Erdtman's acetolysis. An attempt to use H_2O_2 in a water bath in order to remove more organic remains gave negative results. Although the frequency of pollen increased, yet the deteriorated grains were so badly crumpled that it was very hard to identify them.

The number of pollen grains counted per 1 sq. cm was on the average fairly high, only at several levels it dropped rapidly, coming down as 10 grains per sq. cm (see the frequency curve in Text-figs. 4, 5). This was as a rule connected with an increase in the amount of wood detritus or charcoal dust in the sediment. Having not got through the chemical treatment decomposed, they caused a decrease in the number of grains per sq. cm (see samples 42—44 of profile I and 8—12 of profile II). On the other hand, the rapid fall in frequency in samples 33 and 34 of profile I was due to quick sedimentation of mineral material in this horizon. This interpretation would also explain the exceptionally large number of rebedded pollen grains in these samples. The redeposited material most likely came from the Neogenic floriferous layers covering the bottom of the Nowy Targ-Oravian Basin, adjacent to the Pieniny Mts., and washed away by the River Dunajec (Szafer 1946—1947; Oszast 1973; Środoń 1973).

The number of pollen grains counted in particular samples is dependent on frequency. In samples of the lowest frequency 200 AP were counted, whereas in those of the highest frequency at least two slides were counted, 4 sq. cm in area. Pollen grains were always counted in whole slides to avoid statistical errors resulting from their irregular dispersion throughout a surface, which on account of the ununiform accumulation of wood detritus in the slides might have been of consequence in this material.

The results of pollen analysis are given as absolute numbers for each taxon in Tables 1, 2 [1] and as percentages of the total sum (AP + NAP) in diagrams (Text-figs. 4, 5 [2]). The total sum did not include pollen of aquatic plants, spores, indeterminate pollen grains, and indeterminable ones because of their deterioration of various kind, and rebedded pollen

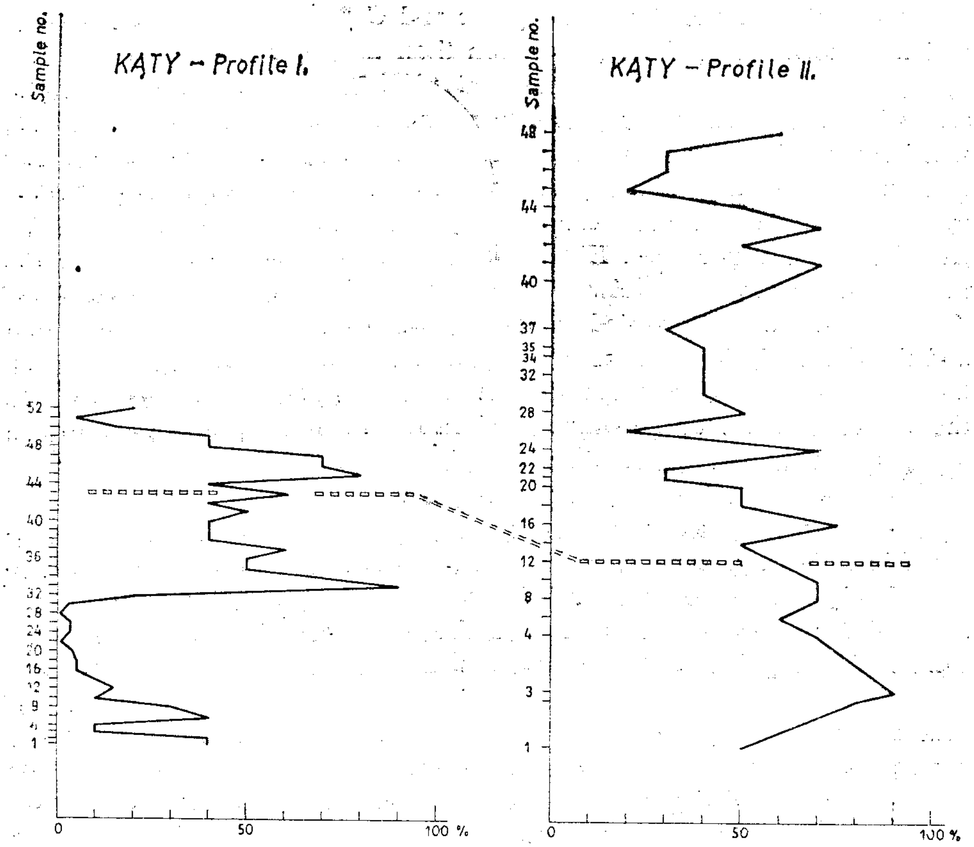
[1] Tables 1—2 are to be found under the cover.

[2] Text-figs. 4, 5 are to be found under the cover.

grains. These last belonged to *Pinus* t. *haploxylon* Rudolph (classical form), *Coniferae*, most probably of Tertiary age, *Taxodiaceae* and *Pterocarya*. In the samples containing rebedded sporomorphs several forms of the *Hystricosphaeridae* were also observed. All the pollen grains regarded as redeposited differed in preservation from the grains assumed as primary. The exine of rebedded pollen grains was degraded to the extent that it seemed quite amorphous.

MICROFOSSIL PRESERVATION

In the course of pollen analysis observations were made on the state of preservation of sporomorphs, adopting Cushing's (1967) deterioration classes for this purpose. Unfortunately, not all deteriorated grains within each taxon distinguished were systematically and seperately noted. On



Text-fig. 3. Percentage of corroded but determinable pollen grains. Broken line indicates the level of sudden crossing for *Picea* and *Pinus* curves

Ryc. 3. Procent skorodowanych ale oznaczalnych ziarn pyłku. Linia przerywana wyznacza poziom gwałtownego skrzyżowania się krzywych *Picea* i *Pinus* the basis of observations of 100 (occasionally 50) pollen grains in a sample, the percentage of deteriorated but determinable grains was estimated (Text-fig. 3).

Corrosion was the main form of deterioration of pollen grains recognized as primary. Corroded grains were, besides, very often broken and crumpled. These last two kinds of deterioration were also observed on non-corroded grains. Indeterminable pollen grains were mainly corroded and crumpled or only crumpled ones but also sporadically these, which were concealed by various opaque particles.

The observations on sporomorph preservation were very important to the appraisal and reliability of the results obtained, since in many samples more than 50 per cent of pollen was found corroded.

The layer of organic mud, thicker in profile I, was examined more closely. In samples 1—14 the percentage of corroded pollen was relatively very high, but at the same time variable. In the remaining part of mud corrosion occurred in 3—5 per cent of grains and was only slight.

Observation of the *Alnus*, *Carpinus* and *Corylus* curves, the pollen of which is more susceptible to corrosion than that of coniferous trees (H a v i n g a 1964), seems to indicate that their percentage may have been somewhat higher in two samples from the bottom part, where corrosion was heaviest. However, this difference is not very great, as can be seen from the *Alnus* curve. In only one of samples 3 and 4, in which the percentage of corroded grains decreases rapidly, the value obtained for *Alnus* rises by about 8 per cent. Higher, despite a continuous decrease in corrosion the percentage of *Alnus* is clearly smaller. These changes in the *Alnus* curve are accompanied by the almost unvariable values of *Carpinus* and the distinctly lower ones of *Corylus*. This admits the supposition that the percentage of these trees was not much higher in the samples from the bottom part. The percentage of indeterminable grains (C u s h i n g 1967), which is not high either, is a good indication of the reliability of the pollen analitycal results for this section.

Above the organic mud the proportion of corroded grains is very variable in both profiles, even within the same type of sediment. This is most likely connected with the degree of oxidation of the solifluctional material. Despite great fluctuations in the percentage of corroded grains the trends of the pollen curves of particular taxa are consistent and independent of pollen deterioration. This is to a great extent due to the fact that the main components of the vegetation of this part of the profile have pollen grains which are easy to determine even if badly deteriorated. The ratio of corroded grains of *Picea* to those of *Pinus* is generally similar to the ratio of their total percentages at particular levels. This allows the assumption that the proportions of pollen of these two trees, occurring in the form of indeterminable fragments excepted from counting, were also in a similar ratio.

The characteristic level of crossing of the curves of *Picea* and *Pinus* at the beginning of zone C observed in all the profiles is undoubtedly associated with a change in the plant composition and not with a change in the degree of pollen deterioration of these genera, for in both profiles the percentage of corroded grains found below this level, in the spruce-dominated zone, was similar or higher. Neither was the ratio of deteriorated grains of *Pinus* to those of *Picea* changed in this horizon.

In the pollen zone E of profile II the proportions of pollen of *Juniperus, Populus, Larix, Cyperaceae, Rubiaceae* and *Gramineae* were probably somewhat higher. In this part of the profile the crumpled grains were slightly more frequent and it may well be that among numerous wood tissue fragments some badly crumpled pollen grains of the above-mentioned taxa were overlooked in the course of analysis. The share of indeterminable pollen grains was also somewhat higher in this part of the profile. Differences in the proportions of the *Compositae Liguliflorae, C. Tubiflorae, Umbelliferae, Lycopodium* and *Sphagnum* could be caused only by changes, resulting from deterioration of other components of the total sum, because the sporomorphs of these taxa were not deteriorated at all or bore only traces of corrosion.

ZONATION

The pollen diagrams from Kąty have many common characteristics, which made it possible to distinguish the same biostratigraphic units in them. Comparison of the present diagrams with those of Dyakowska (1947) did not present any great difficulties despite some differences arising from the lack of pollen of herbaceous plants in these last diagrams and, consequently, from a different basis used to calculate percentages (AP).

The diagrams are divided into local pollen zones A-E, which have their counterparts in Dyakowska's (l.c.) profiles.

Zone A — It is characterized by relatively high values of *Picea*, though with a certain tendency towards decreasing in its lowest part, large quantities of *Alnus* with a maximum in the lower part, a relatively high curve of *Abies* and a continuous low-percentage curve of *Carpinus*. Pollen of thermophilous trees occurs occasionally. Herbaceous plants are represented by low-percentage curves, only *Cyperaceae* show a tendency to dominate locally.

Zone B — The frequence of trees is still high. The amount of *Pinus* increases, the curve of *Abies* drops rapidly to about 1 per cent, the *Picea* values fall gradually and the *Alnus* frequency is temporarily lower. The lower boundary of this zone coincides with the change of sediment. In the upper part of the zone charcoals appear in the sediment.

Zone C — There is a sudden change in the percentages of *Picea* and *Pinus* pollen. *Pinus* becomes rapidly dominant in the spectra. Towards the top of the zone the *Alnus* values fall to about 1 per cent. The frequences of *Betula* t. *alba* and herbs, mainly *Gramineae, Compositae Liguliflorae* and *C. Tubiflorae,* increase slightly. The continuous *Larix* curve begins in the upper part of the zone.

In the transitional period between zones B and C there occurs a sharp peak of *Polypodiaceae* (without perisporium). Some of them have been identified as *Phegopteris dryopteris* on the basis of the fine exine sculpture consisting of low regular polygonal verrucae (S o r s a 1964, Pl. II 15 b, c).

Zone D — A further increase in the percentage of *Pinus* pollen and a consistent fall in *Picea* are observed. There is a low but continuous share of *Larix* and *Betula* t. *alba.* A rise in the values of NAP is caused by an increased amount of *Cyperaceae.* In the upper part of the zone large amounts of *Polypodiaceae* reappear.

Zone E — It is characterized by high NAP values combined with a greater diversity of the taxa distinguished. In addition to *Pinus,* which dominates in the spectra, the continuous curve of *Juniperus* and large amounts of *Salix* pollen in the uppermost part of the zone attract attention. As regards sporophytes, a peak of *Polypodiaceae* is observed at the beginning of the zone and the continuous *Sphagnum* curve is restricted to this zone only.

^{14}C DATING

^{14}C samples were collected as described previously from both profiles Kąty I at a depth of 1·25—1·30 m and Kąty II 2·40—2·50 m. Both samples were chemically treated in order to remove foreign materials which might alter the proper age:

a. by applying 4% hydrochloric acid at 80°C;
b. by applying 1% sodiumhydroxide at 50°C;
c. by again applying HCl solution at 80°C to neutralise the residue.

After working and drying, the material is combusted into CO_2 of which, after purification, the ^{14}C activity is determined. The results are:

GrN — 6251	Kąty I 1·25—1·30 (*Alnus* — wood)	$>$ 51,200 B.P.
GrN — 6803	Kąty II 2·40—2·50 (charcoals, wood and cones of pine)	$>$ 48,200 B.P.

It should be emphasized that such infinite ages may only be compared in cases where the counting circumstances (the particulate counter used, CO_2 pressure, countingtime, etc.) are equal. Consequently we can not draw the conclusion that, in general, the one (infinite) age of a sample exceeds that of another. In this case, where the circumstances have been about, equal, there is a certain possibility (slightly above 50%) that the sample Kąty II is younger than Kąty I.

The important conclusion for us is, that the specific depth of the profiles do not correspond the middle Weichselian interstadials as Hengelo and Denekamp.

VEGETATION AND CLIMATE

The pollen diagrams, the list of macroscopic remains of plants identified from the profile Kąty I and from a single sample from the profile Kąty II (Table 3), the list of mosses (Table 4) and the data obtained from Dyakowska's profiles make up the basis for the reconstruction of the plant succession in this part of the Pieniny Mts., at the time of deposition of the sediments discussed.

The formation of the layer of organic mud, which commenced after a change of the bed of the Dunajec River or owing to its deepening, coincided with the domination of spruce-fir forests in this region. The numerous needles of *Picea abies* and pieces of wood of *Picea* and *Abies*, found in this layer in the profile Kąty I and macroscopic remains of these trees in Dyakowska's profiles III and IV, together with the high number of their pollen in zone A, provide evidence of the occurrence of spruce-fir forests not only on the Pieniny slopes but also in the Dunajec valley of that time. The community that was associated with wetter, probably seasonally flooded, areas was that of alder, most likely *Alnus incana* (numerous big pieces of *Alnus* sp. wood in the profile Kąty I and a fruit of *Alnus incana* in Dyakowska's profile III).

The percentage of pine in pollen zone A is so low that it does not indicate its occurrence *in situ* at the bottom of the valley at that time. The aerial transport of its pollen even from not very remote localities was made difficult, because the spruce-fir communities and alder woods overgrowing the Dunajec terrace were then fairly dense. This is suggested, among other things, by the low values and small diversity of herbaceous plants, although in the river valley itself and on the adjacent slopes there were, as there are now, habitats accessible only to herb communities. The somewhat greater amounts of *Gramineae* and *Cyperaceae* at that time are a local phenomenon, which is evidenced by numerous nuts of *Carex* and groups of *Gramineae* and *Cyperaceae* pollen.

The density of forest communities within the old river-bed area may

Table 5
Tabela 3

List of macroscopic plant remains
Lista szczątków makroskopowych roślin

	Abies alba	Alnus incana	Alnus sp.		Betula t. alba	Juniperus sp.	Larix sp.	Picea abies					Picea vel Larix		Pinus silvestris			Rubus idaeus	Sambucus racemosa	Sambucus sp.	Barbarea vulgaris	Batrachium sp.	Carex sp.	Cerastium arvense	Cirsium sp.	Eriophorum vaginatum	Gramineae	Melandrium cf. rubrum	Mentha cf. aquatica	Ranunculus acer	Ranunculus repens	Ranunculus sp.	Rumex acetosella	Salvia pratensis	Urtica dioica
	w	f	w	ch	f	s	n	n	co	s	co.s	w	w	ch	co	co.s	w	f	f	f	s	f	f	s	f	sc.f	f	s	f	f	f	f	f	f	f
KĄTY II - level: 2,4-2,5 m					2			∞		4	1				5	2		10		2			∞	21	1	2	11	7		4	13	++			
KĄTY I																																			
19		1					2	∞				2						2	1		1		3	3			3				6				2
18								10										3													1				1
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5	1		2					5					4										36						1		2				
4			8			1		2																											1
3			7															2	1												2				
2			3					3																											
1																																			

Abreviations: ch - charcoal, co - cone, co.s - cone scale, f - fruit, s - seed, n - needle, sc.f - sclerenchymatous fibre, t - twig, w - wood

Skróty: ch - węgiel drzewny, co - szyszka, co.s - łuska szyszki, f - owoc, s - nasienie, n - szpilka, cs.f - włókno sklerenchymatyczne, t - gałązka, w - drewno also have been responsible for the only occasional occurrence of *Larix, Juniperus, Salix* and *Populus* pollen grains. The occurrence of willows and poplars in the alder woods and riverside communities and of larches in the spruce-fir forests may have been more abundant than indicated by the palynological data. The same is also true of the occurrence of *Juniperus*, the presence of which is signalled by only sporadic pollen grains. The seed of this shrub found in the profile Kąty I and a number of its needles beside *Abies* and *Picea* needles in Dyakowska's profile IV (l.c., p. 18) show beyond doubt that it grew *in situ* on the Dunajec terrace.

As regards the trees which are more demanding in respect of climate, only the presence of *Carpinus* as a small admixture is confirmed by the results of pollen analysis. Other thermophilous trees and *Corylus* occur in so small amounts that it seems most expedient to assume the long-distance transport of their pollen. Nevertheless, the richly differentiated geologic relief of the Pieniny Mts., their limestone habitats and probably milder climate of this range may have provided favourable conditions for the scattered occurrence of these trees both towards the end of the Eemian interglacial and during the climatic optimum of the Brørup interstadial. Thus, it may well be that their slight number in the diagrams is connected, as in the case of *Juniperus* and *Larix*, with the local over-representation of *Picea* and *Alnus*.

A break in the accumulation of organic mud, caused by a flood of the Dunajec River, coincides with the decline of the dominance of fir and with a seasonal decrease in the number of alder in the close surroundings. The series of river sediments signals a change in hydrological conditions parallel to the deterioration of climate, which is evidenced by the directly following onset of solifluctional processes.

In the period represented by the pollen phase B the spruce and alder communities dominated in the study area. However, a consistent withdrawal of the spruce is observed in the upper part of the zone. This process, initiated by a change in the climatic conditions, was intensified by fires, which is indicated by numerous charcoals identified as *Picea* vel *Larix*. In this case it is more probable that they belong to *Picea*.

The progressive degradation of the forest communities in the Dunajec valley gradually created favourable conditions for the development of herbaceous vegetation, associated chiefly with damp habitats (rise in *Cyperaceae, Rubiaceae, Compositae, Thalictrum, Plantago lanceolata, Valeriana, Polypodiaceae* and *Sphagnum*).

The rise in the percentage of *Pinus* t. *silvestris*, at first presumably connected with an increased influx from not very remote sites, becomes so rapid at the beginning of zone C that it suggests a fairly considerable expansion of this tree at that time. Numerous pine stomata appear in the sediment and are recorded up to the top of the profile Kąty I and in profile II half way through zone D (up to sample 26 inclusive). An analysis of the macroscopic remains gave a fragment of *Pinus silvestris* wood in profile I (decline of phase C) and cones and seed scales in profile II (boundary between zones C and D). The perfect state of preservation of the cones, without any traces of rolling, proves that they came from the close neighbourhood.

An increase in the percentage of birch and somewhat later in that of larch and juniper accompanies the expansion of pine. In spite of the low values of *Betula* t. *alba* pollen the presence of birches from this group *in situ* has been corroborated by the well-preserved fruits found

Table 4
Tabela 4

The occurrence of moss remains in Dyakowska's (1947) material and in profile I of the present study (det. K. Karczmarz)
Występowanie szczątków mchów w materiale Dyakowskiej (1947) i w profilu I obecnie opracowanym (oznaczył K. Karczmarz)

Marsch and spring mosses Mchy młak i źródlisk	Dyakowska 1947	Profile I Profil I
Calliergon giganteum (Shimp.) Kindb.	4	—
* *Campylium stellatum* (Hedw.) J. Lange et C. Jens	1	—
Cratoneuron commutatum (Hedw.) Roth	1	—
C. filicinum (Hedw.) Spruce	1	2
* *Ctenidium molluscum* (Hedw.) Mitt.	3	—
Drepanocladus revolvens (Sw.) Warnst.	2	—
D. aduncus var. *kneiffii* (Schimp.) Mnkm.	5	—
* *Hygrohypnum palustre* B.S.G.	3	1
Forest (ground) and meadow mosses Mchy naziemne leśne i łąkowe		
Eurhynchium zetterstedtii Störmer	2	—
Plagiomnium affine (Funck) Kop.	—	1
Drepanocladus revolvens (Sw.) Warnst.	4	1
Rocky and epiphytic mosses Mchy naskalne i epifityczne		
Amblystegium varium (Hedw.) Lindb.	1	1
Pterygynandrum filiforme Hedw.	1	—

Species marked with the sign * may also grow in habitats characteristic of the mosses of the third group. On damp calcareous rock they frequently grow close to each other and in abundance.

Gatunki ze znakiem * mogą występować również na siedliskach charakterystycznych dla mchów grupy trzeciej. Na wilgotnym podłożu skał wapiennych rosną często wspólnie i w dużej ilości.

in the profile Kąty II (at the boundary between zones C and D). Larch needles were also taken at the same level (top layer in the profile Kąty I).

Spruce occurred in the close surroundings throughout the period covered by zone D, which is evidenced by its numerous macroscopic remains at the transition of zones C and D in both profiles. The composition of the forest communities did not undergo essential changes then. However, the mutual relations between the main components of these communities changed distinctly and the number of *Larix* increased. The ratio of these communities to those of open areas also changed gradually in favour of these last. In the pollen diagram from profile II this is reflected chiefly by a rise in *Cyperaceae* and *Compositae Liguliflorae*.

The herbaceous plant communities, which gain in importance from the very bottom of zone C, are now enriched by new species, which come from both damp (*Plantago maritima, Polemonium*) and dryer habitats (*Armeria, Elymus*). Dr K. Karczmarz determined 3 species of mosses representing open communities — marsh and rocky habitats.

The nature of the vegetation described indicates that the Pieniny Mts. were then within the range of the timber line.

The gradual deterioration of the climate leads to the intensification of solifluctional processes in the earlier part of zone D, which is evidenced by the occurrence of clumps of fine angular calcareous gravel in the sediment. At the same time small pieces of wood and charcoal disappear from the sediment, which is probably connected with the derivation of the solifluctional material from places destitute of arboreal vegetation.

The upper part of profile II records a further cooling and moistening of the climate, resulting in the expansion of herbaceous plant communities. It is only now that *Rubiaceae, Rosaceae* and *Umbelliferae* appear in fairly large amounts beside *Cyperaceae, Gramineae* and *Compositae*, which have been quantitatively dominant in the composition of herbaceous plants so far. The families *Rosaceae* and *Umbelliferae* are represented by different species (several morphologic types of pollen). *Bupleurum, Papaver, Trollius* and *Campanula* are added to the list of plants represented by sporadic pollen grains. These data suggest not only the expansion of the herbaceous plant communities in various habitats but also an enrichment in their composition.

The progressing deterioration of the climate had probably led to the complete withdrawal of the spruce from this part of the Pieniny Mts. On the surrounding rocks and in places less exposed to solifluctional processes there could grow groups of *Pinus silvestris* (perhaps also *P. mugo*) with an admixture of *Larix, Betula* t. *alba* and probably single specimens of *Pinus cembra* and *Sorbus aucuparia*. The percentages of *Juniperus* and *Betula* t. *nana* increased distinctly. *Alnus incana* and *Populus* may have occurred occasionally in the Dunajec valley and *Hippophaë rhamnoides* appeared then. The high frequency of *Salix* in the top part is, in all probability, connected with the local over-representation of pollen (numerous groups) produced by shrubby willows (small pollen grains with homobrachate reticulum — *Salix* t. *glauca*, Faegri and Iversen 1964).

All the changes observed in zone E suggest that at that time this part of the Pieniny Mts. could be slightly above the timber line.

A COMPARISON OF THE FLORA FROM KĄTY WITH OTHER FOSSIL FLORAE OF SOUTHERN POLAND

The determination of the age of the flora from Kąty on the basis of the palaeobotanical results is not an easy task, because both the present profiles and Dyakowska's (1947) profiles III and I, begin in a period referable either to the late temperate phase of an interglacial or to the optimum phase of an interstadial. The lack of interglacial sites in the northern part of the Carpathians and in their nearest foreland makes this task very difficult. The stratigraphic data (see p. 168), however, permit the exclusion of the florae representing periods older than the Eemian interglacial from these considerations.

In Poland the nearest mountainous site of a flora regarded as Eemian is at Polanica in the Kłodzko region of the Sudetes (Walczak, Szczypek 1966; Szczypek 1974). Unfortunately, the pollen diagram from Polanica has few features characteristic of the Eemian interglacial. The differences in relation to the diagrams representing a plant succession typical for this interglacial are so great that they authorise us to call in question the Eemian age of this flora. This is a problem that needs separate considerations, here only the explanation is given why we do not compare the flora from Kąty with that from Polanica.

It does not seem expedient to compare the Kąty flora with such Eemian florae as those from Bedlno, Leśna Niwa, Szczerców, Dzbanki or Imbramowice. To be sure, they are the southernmost Polish sites but anyway all of them are situated in the lowlands.

This being so, the only acceptable comparison is that with the pollen diagram of the Eemian flora from Gánovce (Kneblová 1958, 1960) in the valley of the Poprad River in Slovakia, as the crow flies about 40 km south-east of Kąty. Although in the close vicinity of Gánovce there is another site, "Pod borom", near Spisska Teplica, referred to the Eemian interglacial (Krippel 1961), yet the age determination in the case of this site is questionable. This peatbog is situated among Holocene peatbogs investigated by the same author (Krippel 1963). It may be inferred on the basis of the plant succession presented by the pollen diagram from the "Pod borom" that it is also a Holocene peatbog, devoid of the top part of sediments. The pollen diagram very much resembles the bottom part of the diagrams from Tatranský Domov or Strebské Pleso (Krippel 1963) and has hardly any features in common with the indubitably Eemian profile from Gánovce. This question might be explicitly decided by the radiocarbon dating of the site.

The pollen diagram of the travertines from Gánovce provides a very typical picture of the Eemian vegetation. In her discussion of the interstadial flora from Český Těšin in relation to different florae then referred to the Göttweig or the Aurignacian interstadial, Kneblová-Vodičková (1963) claims that the flora from Kąty, dated by Środoń (1952, 1960) to the Aurignacian interstadial, does not come from this period but should be ascribed to the decline of the Eemian interglacial. Her opinion is based on the similarity of the pollen diagrams from Kąty and Gánovce, but it seems incorrect. The high frequencies of *Carpinus* are admittedly characteristic of the younger phase of the Eemian interglacial (zone "g" acc. to Jessen and Milthers 1928) in most European sites. In the period of maximum share of *Picea* and *Abies* at Gánovce, and thus the period with which the bottom part of the diagrams from Kąty can be compared, the amount of *Carpinus* ranges from 12·0 to 35·4 per cent of the total pollen. This proves a high share of the hornbeam in the forest communities of that time. There are no good reasons to think that at the same time the hornbeam could not occur in similar proportions in the Pieniny Mts., which are characterized by a great diversity of habitats associated with the rich relief of the region and the high content of calcium carbonate in the soil. However, the percentage of *Carpinus* in the pollen diagrams from Kąty was below 2 per cent of the total in the spruce-fir period (only twice reaching 2·3 and 2·9 per cent respectively). This prompts us to put forward the supposition that the hornbeam was at most an additional species in the then prevailing stands in this part of the Pieniny Mts. These great divergencies lead to the conclusion that the profile from Kąty cannot be the same age as the upper part of the profile from Gánovce.

The nature of the vegetation represented by the lower parts of the profiles from Kąty permits, as has already been said, the recognition of this flora as interstadial. Out of the interstadials of the last glaciation known from Southern Poland, the Hengelo and Denekamp interstadials can be excluded from our considerations, because they were considerably cooler and of a younger age than this obtained for the flora from Kąty. The dates obtained however imply that the true age of this sediment can be any older age. Thus, none of the interstadials of the early Vistulian can be omitted in the considerations. It seems however that the climatic conditions necessary for the development of such forest communities as have been described from Kąty prevailed in the Brørup interstadial.

Results of studies made in north-western Germany (Averdieck 1967) made it possible to distinguish the Odderade interstadial in the early period of the last glaciation. It was younger and cooler than the Brørup interstadial, from which it was separated by a not very long-lasting stadial. No profile has, as yet, been found in Poland which would have two successive warm oscillations like those in the profile from Odderade (Averdieck 1967). It cannot therefore be settled decisively whether the florae now referred to the Brørup interstadial are really of the same age or whether they belong to two different though neighbouring interstadials. Some data hinting the possibility of distinction of two interstadial oscillations of this rank are provided by the profile from Ściejowice near Cracow (Mądalski 1935; Dyakowska 1939), referred by Środoń (1952) to the Brørup interstadial. The pollen diagram from Ściejowice consists of four parts seperated by sections without pollen and the behaviour of *Picea* and *Alnus* curves as well as of *Pinus, Betula* and *Salix* suggests that two or even three warm oscillations can be distinguished in this diagram. Comparisons with the diagrams from Kąty show relatively large amounts of *Abies* occurring in conjuction with higher proportions of *Picea* and *Alnus*, in the profile from Ściejowice, which certainly deserves a revision.

Two sites situated furthest to the south-west, Brzozowica and Łabędy (Gilewska, Stuchlik 1958; Ralska-Jasiewiczowa 1958), were dated by the authors to the Ohe interstadial, whereas Środoń (1960) referred them to the Aurignacian interstadial (Brørup), calling in question the geomorphological criteria applied as bases for their age determination. If the inclusion of these florae in the Brørup interstadial is correct, it should be emphasized that the vegetation represented by their pollen diagrams is more differentiated and richer than it is at the remaining sites in southern Poland. It may well be that these differences are connected with the climate of Silesia, which is milder than in the piedmont region. Nevertheless the problem of age of the interstadial florae from Brzozowica and Łabędy still remains open.

The Carpathian sites at Ziębówka, Maniowy and Poronin (Środoń 1952) have been referred to the Brørup interstadial chiefly on the basis of geomorphological data. However fragmentary, the results of palaeobotanical studies permit the admission of this age for them.

In analysing further sites from southern Poland ascribed to the Brørup interstadial, one comes to the conviction that only those at Wadowice (Sobolewska, Starkel, Środoń 1964) and Brzeziny near Czorsztyn (Birkenmajer, Środoń, 1960) may be used for comparisons with Kąty and considerations on the character of the vegetation of this interstadial. The common feature of the vegetation during the climatic optimum at Kąty and the vegetation of the two above-mentioned sites is the great amount of spruce and alder, whereas the proportions of other components which could occur *in situ* in the areas represented by these profiles are different. The forest communities represented by the profile from Wadowice in the foot-hills of the Carpathians are the richest in termophilous components. *Tilia* played a fairly important part in these communities and *Quercus, Corylus* and *Carpinus* may have occurred singly.

The forest vegetation of the climatic optimum at Brzeziny is cooler in character. The pollen diagram from this site contains only traces of trees of higher thermal demands. This difference from nearby Kąty was probably due to the situation of Brzeziny on the flysch slopes of the Gorce range. Its situation at the bottom of the Nowy Targ Basin, characterized by a distinct continentality of climate (great amplitudes of temperatures) in comparison with the surrounding ranges of mountains, may also have had an influence on the composition of vegetation (K o r n a ś 1955). The limestone Pieniny Mts. have a much milder climate, which, together with their varied relief, induces the great diversity of their contemporary flora (P a n c e r - K o t e j o w a 1973). Also in the past these factors may have determined the formation of communities here which were richer than those on the slopes of the adjacent range of the Gorce Mts. In the light of the foregoing the attribution of the flora from Kąty to the Brørup interstadial is plausive.

B a s t i n (1971) made an attempt to differentiate the age of the florae discussed, referring the flora from Wadowice to the Brørup interstadial and that from Brzeziny to the Odderade interstadial. In this he based himself, in accordance with the criterion proposed by A v e r d i e c k (1967), on the lack of *Picea omorikoides* pollen in the profile from Brzeziny, but he did not take into consideration the fact that in the study of material from this site no attention had been given to the differentiation of the *Picea* pollen.

At Kąty the generally bad state of preservation of *Picea* pollen also made it impossible to take measurements in a consistent way. An attempt in this respect was made for three samples, 4, 28 and 48, from the profile Kąty I, in which the material was somewhat less corroded. Observations were made on 50 grains in each sample. However, it appeared that even in these samples the spruce pollen grains were not suitable for measuring, since they were flaccid and mostly crumpled. In samples 4 and 28 we managed to measure only one pollen grain in each and in sample 48 two grains. The height of attachment of their sacs was 82·4, 62·7, 63·8 and 68·2 μ. The measurements indicate that these grains belong to *Picea abies,* which however, considering their slight number, does not allow any conclusions which species of *Picea* occurred at Kąty. The macroscopic remains (needles) derived from both profiles belong exclusively to *P. abies.* Lack of evidence for the occurrence of *Picea omorikoides* at Kąty might suggest, according to the recently accepted criteria, that this flora derives from the Odderade interstadial. Nevertheless, the nature of the vegetation described from Kąty, despite missing *P. omorikoides,* refers it to the Brørup rather than to the cooler Odderade interstadial.

AGE OF THE FLORA FROM KĄTY IN THE LIGHT OF THE RESULTS OBTAINED IN GEOMORPHOLOGICAL STUDIES

The results of the present palaeobotanical studies and radiocarbon dating of the sediment fail to determine the age of the flora from Kąty definitively. This being so, attention should be given to geomorphological data of stratigraphic importance.

At Brzeziny, situated at a distance of 10 km from Kąty, up the Dunajec River, the fossil flora, already mentioned several times before and referred to the Brørup interstadial, occurs in a geological position analogous to that at Kąty (B i r k e n m a j e r, Ś r o d o ń 1960). Here the interstadial peats rest on a thick layer of fluvial Tatra gravels and are covered, as at Kąty, by a thick layer of solifluctional clays of the last glaciation age. The upper boundary of gravels at Brzeziny is placed at an altitude of 511 m a.s.l. and the upper boundary of gravels underlying the organic mud at Kąty is at an altitude of 490 m, the difference being 21 m. The surface of contemporary gravel-banks of the Dunajec is at 500 m at Brzeziny and at 467 m at Kąty. The difference is 12 m greater than in the previous case, which is connected with the greater deepening of the river channel in the youngest phase of the Late glacial and Holocene and its increased down grade. Thus, it may be admitted that the Tatra gravels underlying the florae at Brzeziny and Kąty are the same age and consequently the florae of these sites are contemporaneous or at any rate referrable to the early period of the Vistulian glaciation. This age determination is not inconsistent with the results of palaeobotanical studies and radiocarbon dating.

The interstadial age of the sediment at Kąty is also suggested by the order of the deposits, similar to that in other Carpathian profiles (Wadowice, Zator, Myślenice, Dobra), in which the florae from the interstadials of the last glaciation have been demonstrated (S o b o l e w s k a, S t a r k e l, Ś r o d o ń 1964; K o p e r o w a, Ś r o d o ń 1965; Ś r o d o ń 1968). In these profiles, representing the middle terrace, the organic sediments and silts of flood facies occur as a rule between the underlying fluvial gravels and the overlying layer of solifluctional clays or loess. In S t a r k e l's (1968) opinion, the cycles of alluvial-deluvial sedimentation derived from one glacial are characteristic of terraces in many Carpathian valleys.

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STRESZCZENIE

PÓŹNOPLEJSTOCEŃSKA FLORA Z KĄTÓW KOŁO SROMOWIEC WYŻNICH (PIENINY)

Pozycja stratygraficzna flory plejstoceńskiej z Kątów jest kontrowersyjna. Najczęściej jest ona wiązana ze schyłkiem interglacjału eemskiego, ale nie brak również wypowiedzi, że jest to flora interstadialna z wczesnego okresu ostatniego zlodowacenia. Praca zawiera ponowną próbę wyjaśnienia tego spornego zagadnienia, na podstawie nowo opracowanych materiałów i dziś już dużo lepiej poznanej późnoplejstoceńskiej historii roślinności w Karpatach Zachodnich.

Dwa świeżo opracowane profile metodą analizy pyłkowej i makroskopowej w zasadzie nie odbiegają swą treścią od wyników uzyskanych na tym stanowisku przez Dyakowską (1947). Z większą natomiast dokładnością można było przedstawić charakter zmieniających się w profilu osadów, jak również i sukcesję roślinności uwarunkowaną stopniowo pogarszającymi się warunkami klimatycznymi.

Flora z Kątów jest starsza od 51 200 lat B.P. (GrN 6251), a tym samym datowanie radiowęglem nie usunęło wątpliwości co do jej pozycji w schemacie stratygraficznym plejstocenu.

Opracowana flora występuje w profilu terasy średniej, zbudowanej z osadów wyraźnie różniących się składem, których następstwo jest analogiczne jak w innych profilach karpackich i Podkarpacia, zawierających flory kopalne z interstadiałów ostatniego zlodowacenia (Brzeziny koło Czorsztyna, Dobra, Myślenice, Wadowice, Zator, Brzeźnica nad Wisłoką). W profilach z wymienionych stanowisk osady organogeniczne pojawiają się z reguły pomiędzy warstwą żwirów fluwialnych w spągu a pokładem glin soliflukcyjnych lub lessu w stropie. Ciągłość sedymentacyjna pomiędzy warstwą torfów lub mułków interstadialnych a nadległym pokładem glin soliflukcyjnych lub lessu jest zazwyczaj wyraźna. Taki cykl sedymentacji rzeczno-stokowej, powtarzający się w dolinach karpackich z dużą regularnością, jest — zdaniem Starkla (1968) — charakterystyczny dla utworów jednego okresu lodowego, w danym przypadku dla utworów ostatniego zlodowacenia. Występujące w spągu terasy żwiry fluwialne wiążą się najprawdopodobniej z chłodnym, a przede wszystkim wilgotnym schyłkiem interglacjału eemskiego i jego pograniczem z okresem zlodowacenia Vistulian.

Wyniki analizy pyłkowej oraz szczątków makroskopowych stanowią podstawę do odtworzenia sukcesji roślinności w tej części Pienin w okresie odkładania się omawianych osadów.

W czasie tworzenia się mułku organicznego panującym zbiorowiskiem były lasy świerkowo-jodłowe, i to nie tylko na stokach Pienin, ale także

w ówczesnej dolinie Dunajca. Na terenach podmokłych występowało zbiorowisko olszy, najprawdopodobniej *Alnus incana*. Z drzew o wyższych wymaganiach klimatycznych tylko obecność *Carpinus in situ* wydaje się dość pewna. Niewielkie ilości pyłku innych drzew ciepłolubnych pochodzą zapewne z dalekiego transportu.

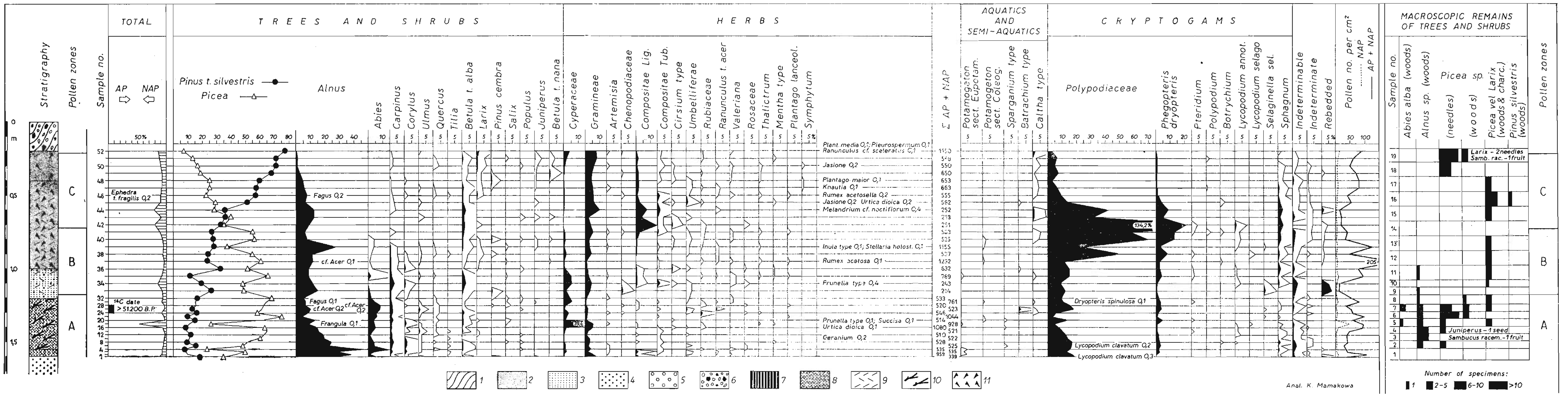
Przerwa w akumulacji mułku organicznego jest synchroniczna z początkiem degradacji dotychczasowych zbiorowisk leśnych. Znika całkowicie w tym czasie jodła, zmniejsza się udział olszy oraz zaczyna się konsekwentne wycofywanie świerka. Zmiany te stwarzały stopniowo warunki dla rozprzestrzeniania się sosny, której obecność w dolinie Dunajca w okresie gwałtownego spadku udziału świerka (strefa C) jest potwierdzona występowaniem szczątków makroskopowych. W miarę zmian zachodzących w zbiorowiskach leśnych, na znaczeniu zyskują zbiorowiska roślin zielnych, wzbogacane przez nowe gatunki i to zarówno na siedliskach wilgotnych, jak i stosunkowo suchych. Zmiany obserwowane w diagramie pyłkowym stropowej części profilu II sugerują, że w tym czasie tereny przyległe do badanego stanowiska znalazły się prawdopodobnie powyżej górnej granicy lasu.

Ocena wieku flory z Kątów na podstawie wyników badań paleobotanicznych nastręcza trudności, ponieważ wszystkie profile zbadane z tego stanowiska rozpoczynają się w okresie, który można odnieść zarówno do schyłku interglacjału, jak i do optymalnej fazy interstadiału.

Porównanie obrazu roślinności z Kątów ze schyłkową częścią typowo wykształconego interglacjału eemskiego z Gánoviec na Słowacji prowadzi do wniosku, że profil z Kątów nie odpowiada schyłkowej części profilu z Gánoviec. Jak bowiem wiadomo, wysokie wartości *Carpinus* są charakterystyczne dla młodszej części interglacjału eemskiego. W Gánovcach wahają się one w tym okresie od 12,0% do 35,42%, natomiast udział *Carpinus* w Kątach nie przekracza 2,9%

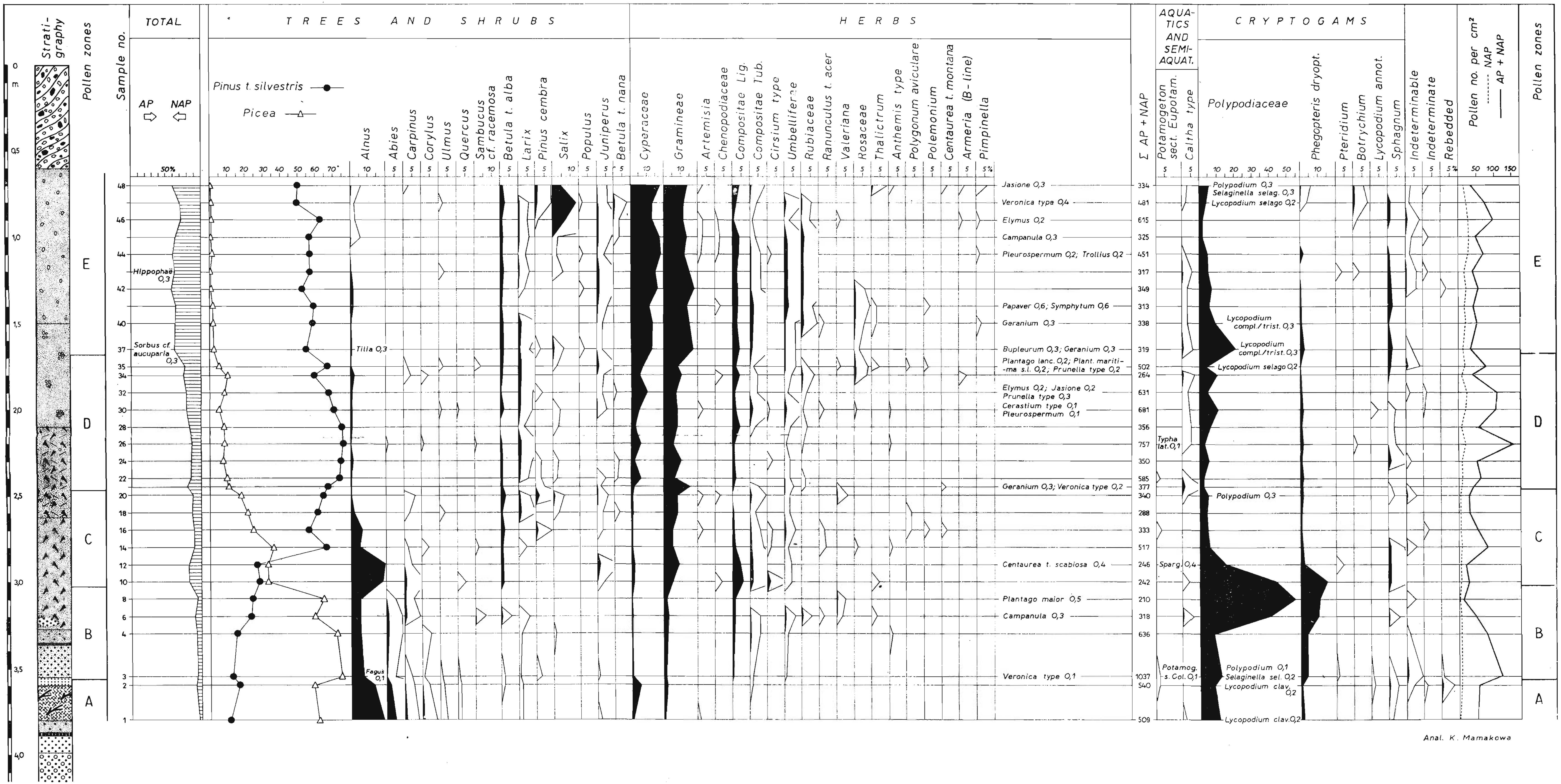
Charakter roślinności reprezentowanej przez spągową część profili z Kątów, mimo pewnych cech właściwych tylko temu stanowisku, nie koliduje w sposób istotny z obrazem roślinności poznanym na stanowiskach karpackich i podkarpackich flor kopalnych, zaliczanych na podstawie wyników badań paleobotanicznych i geomorfologicznych do interstadiału Brørup (Brzeziny, Wadowice, Ściejowice).

Na podstawie powyższych przesłanek autorzy przyjmują dla flory z Kątów wiek interstadiału Brørup.



Text-fig. 4. Kąty — profile I. Black silhouettes represent percentages, white silhouettes percentages enlarged 10 ×. Sediment symbols: 1 — topsoil, 2 — silty clay, 3 — silt, 4 — sand, 5 — gravel, 6 — sandstones (black) and calcareous gravel (white), 7 — rusty hard-pan, 8 — organic mud, 9 — small fragments of wood, 10 — big fragments of wood, 11 — charcoals

Ryc. 4. Kąty — profil I. Czarne sylwetki przedstawiają procenty, białe wartości procentowe powiększone 10 ×. Oznaczenia osadów: 1 — gleba, 2 — mułowaty ił, 3 — muł, 4 — piasek, 5 — żwir, 6 — piaskowce (czarne) i wapienne (białe) żwiry, 7 — rdzawa polepa, 8 — mułek organiczny, 9 — małe ułamki drewien, 10 — duże ułamki drewien, 11 — węgielki



Text fig. 5. Kąty — profile II. See explanation for Fig. 4
Ryc. 5. Kąty — profil II. Patrz objaśnienia pod ryc. 4

Kąty - Profile I. Absolute numbers of sporomorphs
Kąty - Profil I. Bezwzględne ilości sporomorf

Sample No	Abies	Acer	Alnus	Betula t. alba	Betula t. nana	Carpinus	Corylus	Ephedra t. frag.	Fagus	Frangula alnus	Juniperus	Larix	Picea	Pinus cembra	Pinus t. silvestris	Populus	Quercus	Salix	Tilia	Ulmus	AP - sum
52	-	-	4	1	1	1	-	-	-	-	1	14	85	-	892	-	-	-	-	1	1000
51	-	-	7	4	2	1	-	-	-	-	3	3	76	-	402	-	1	1	-	-	500
50	-	-	4	2	1	1	-	-	-	-	1	4	93	-	391	1	2	-	-	-	500
49	-	-	18	3	6	-	-	-	-	-	1	2	125	1	444	-	-	-	-	-	600
48	-	-	31	2	1	1	1	-	-	-	1	2	167	5	389	-	-	-	-	-	600
47	-	-	36	7	-	1	-	-	-	-	1	3	169	1	380	-	1	-	-	1	600
46	-	-	42	3	-	1	1	1	1	-	-	3	129	-	317	-	1	-	1	-	500
45	-	-	37	3	-	2	-	-	-	-	2	-	167	-	288	-	-	-	-	1	500
44	-	-	31	6	-	1	-	-	-	-	-	-	72	-	90	-	-	-	-	-	200
43	-	-	27	3	1	-	-	-	-	-	1	-	87	-	79	1	-	-	-	1	200
42	-	-	23	5	-	-	-	-	-	-	-	1	88	-	83	-	-	-	-	-	200
41	-	-	35	6	-	2	-	-	-	-	-	-	309	-	148	-	-	-	-	-	500
40	2	-	39	3	1	-	-	-	-	-	1	1	301	4	147	1	-	-	-	-	500
39	5	-	315	9	-	6	-	-	-	-	2	4	430	-	325	-	1	2	-	1	1100
38	1	-	59	2	-	3	1	-	-	-	-	3	297	2	129	-	1	-	1	1	500
37	1	1	139	4	1	8	4	-	-	-	-	3	747	-	290	-	-	1	-	1	1200
36	2	-	53	1	-	3	5	-	-	-	-	1	326	-	207	2	-	-	-	-	600
35	16	-	64	11	-	8	-	-	-	-	-	-	509	-	89	-	1	1	-	1	700
34	-	-	28	6	-	7	2	-	-	-	-	-	117	-	47	-	-	-	-	-	207
33	1	-	32	2	-	2	1	-	-	-	-	-	104	2	56	-	-	-	-	-	200
32	12	-	28	2	-	2	1	-	-	-	-	-	362	1	89	1	1	1	-	-	500
30	32	-	50	2	-	8	-	-	1	-	1	-	488	-	113	1	2	1	-	1	700
28	43	1	34	1	-	7	1	-	-	-	-	-	325	1	82	-	2	2	-	1	500
26	42	1	53	2	-	9	-	-	-	-	-	-	318	-	58	1	2	-	-	4	500
24	31	-	46	7	-	9	-	-	-	-	-	-	317	-	87	-	2	-	-	1	500
22	61	-	41	5	-	6	-	-	-	-	-	-	782	-	102	-	2	-	-	1	1000
20	18	-	65	3	-	10	3	-	-	-	-	1	319	-	76	-	2	2	-	-	500
18	43	-	80	7	-	9	11	-	-	1	-	-	242	-	102	-	2	1	-	2	500
16	55	-	155	2	-	12	1	-	-	-	-	-	679	-	92	-	2	-	-	2	1000
14	17	-	81	3	-	5	2	-	-	-	-	1	336	-	50	-	1	-	1	3	500
12	8	-	98	-	-	7	-	-	-	-	-	1	320	-	62	1	2	-	-	1	500
10	13	-	101	-	-	8	5	-	-	-	-	-	314	-	57	-	-	-	1	1	500
8	20	-	130	3	-	12	9	-	-	-	-	-	272	-	50	1	1	1	-	1	500
6	24	-	121	5	-	7	6	-	-	-	-	-	253	-	82	-	-	-	1	1	500
4	72	-	244	5	-	5	3	-	-	-	-	-	122	-	44	1	3	-	-	1	500
3	21	-	149	2	-	7	7	-	-	-	-	-	266	-	46	-	-	-	1	1	500
2	6	-	326	1	-	3	2	-	-	-	-	-	375	-	86	-	-	-	1	-	800
1	17	-	93	3	-	2	1	-	-	-	1	-	117	2	63	-	-	-	-	1	300

Sample No	Artemisia	Calluna	Caryophyllaceae	Chenopodiaceae	Cirsium type	Compositae Liguliflorae	Compositae Tubiflorae	Cruciferae	Cyperaceae	Ericaceae	Filipendula	Geranium	Gramineae	Inula type	Jasione	Knautia	Melandrium cf. noctifl.	Mentha type	Plantago lanceolata	Plantago major	Plantago media	Pleurospermum	Prunella type	Ranunculaceae	Ranunculus t. acer	Ranunculus cf. sceleratus
52	2	-	-	1	-	5	4	1	44	-	-	-	86	-	-	-	-	-	-	-	1	1	-	1	-	1
51	-	-	-	-	-	8	1	-	10	-	-	-	46	-	-	-	-	1	-	-	-	-	-	-	-	-
50	1	1	-	-	1	3	3	-	4	-	-	-	32	-	1	-	-	-	-	-	-	-	-	-	1	-
49	-	-	-	1	1	9	1	1	2	1	-	-	31	-	-	-	-	-	-	-	-	-	-	-	-	-
48	-	-	-	-	2	13	2	-	1	-	-	-	28	-	-	-	-	-	-	1	-	-	-	-	-	-
47	2	1	-	-	-	13	-	-	4	-	-	-	35	-	-	1	-	-	-	-	-	-	-	-	2	-
46	-	-	-	1	-	7	7	-	3	-	-	-	30	-	-	-	-	-	1	-	-	-	-	-	1	-
45	-	-	-	-	1	13	2	-	3	-	-	-	33	-	1	-	-	1	-	-	-	-	-	-	-	-
44	-	-	-	-	-	19	5	-	1	-	-	-	25	-	-	-	1	-	-	-	-	-	-	-	1	-
43	-	-	-	-	1	9	1	-	-	-	-	-	6	-	-	-	-	-	-	-	-	-	-	-	-	-
42	-	-	-	-	2	36	1	-	-	-	-	-	10	-	-	-	-	-	-	-	-	-	-	-	-	-
41	1	-	-	1	-	15	4	-	5	-	-	-	31	-	-	-	-	-	1	-	-	-	-	-	-	-
40	-	-	-	-	1	4	-	-	7	-	-	-	15	-	-	-	-	-	-	-	-	-	-	2	-	-
39	1	-	-	-	1	5	1	1	5	-	-	-	33	1	-	-	-	-	-	-	-	-	-	-	2	-
38	-	-	-	-	-	2	-	-	9	-	-	-	24	-	-	-	-	-	-	-	-	-	-	-	1	-
37	-	1	1	-	-	-	1	-	4	-	-	-	14	-	-	-	-	-	1	-	-	-	-	-	2	-
36	-	-	-	-	4	4	1	-	6	-	-	-	13	-	-	-	-	1	-	-	-	-	-	-	-	-
35	1	-	-	-	-	4	-	-	36	-	-	-	20	-	-	-	-	1	1	-	-	-	-	-	1	-
34	-	-	-	1	1	2	3	1	13	-	-	-	11	-	-	-	-	-	-	-	-	-	1	-	<	-
33	-	-	-	2	-	-	-	1	3	-	-	-	7	-	-	-	-	-	-	-	-	-	-	-	-	-
32	1	-	-	-	-	-	-	1	23	-	-	-	5	-	-	-	-	-	-	-	-	-	-	1	-	-
30	-	-	-	-	-	2	1	-	46	-	-	-	6	-	-	-	-	-	-	-	-	-	-	-	1	-
28	-	-	-	1	-	1	-	-	8	-	-	-	6	-	-	-	-	-	1	-	-	-	-	-	-	-
26	-	-	-	-	-	1	1	-	4	-	-	-	10	-	-	-	-	-	-	-	-	-	-	-	3	-
24	1	-	-	1	-	-	-	1	20	-	-	-	11	-	-	-	-	-	-	-	-	-	-	-	-	-
22	-	-	-	-	-	-	1	-	20	-	-	-	19	-	-	-	-	-	1	-	-	-	-	2	-	-
20	-	-	-	-	1	-	-	-	7	-	-	-	6	-	-	-	-	-	-	-	-	-	-	-	-	-
18	2	-	-	-	-	1	-	-	366	-	-	-	50	-	-	-	-	1	-	-	-	-	1	1	-	-
16	-	-	-	-	3	1	1	-	14	-	1	-	54	-	-	-	-	-	-	-	-	-	-	-	-	-
14	-	-	2	-	-	-	2	-	6	-	-	-	11	-	-	-	-	-	-	-	-	-	-	-	-	-
12	-	-	-	-	-	1	1	-	1	-	-	-	6	-	-	-	-	-	-	-	-	-	-	-	-	-
10	-	-	-	-	-	-	1	1	2	-	-	1	17	-	-	-	-	-	-	-	-	-	-	-	-	-
8	-	-	1	-	-	1	2	-	2	1	-	-	18	-	-	-	-	1	-	-	-	-	-	2	-	-
6	1	-	-	-	-	-	1	-	8	-	-	-	12	-	-	-	-	-	-	-	-	-	-	-	-	-
4	1	-	-	-	-	-	2	-	7	-	-	-	21	-	-	-	-	-	-	-	-	-	-	-	-	-
3	1	-	-	-	-	8	2	-	9	-	-	-	11	-	-	-	-	-	-	-	-	-	-	-	1	-
2	1	-	-	-	-	4	1	-	2	-	-	-	42	-	-	-	-	-	-	-	-	-	-	-	1	-
1	-	-	-	-	-	6	-	-	3	-	-	-	28	-	-	-	-	-	-	-	-	-	-	-	-	-

Sample No	Rosaceae	Rubiaceae	Rumex acetosa	Rumex acetosella	Rumex sect. Lapathum	Stellaria holostea	Succisa	Symphytum	Thalictrum	Umbelliferae	Urtica	Urtica dioica	Valeriana	Veronica type	NAP - sum	Batrachium type	Botrychium	Caltha type	Dryopteris spinulosa	Lycopodium annotinum	Lycopodium clavatum	Lycopodium selago	Lycopodium sp.	Phegopteris dryopteris	Polypodiaceae
52	-	1	-	-	-	-	-	-	-	-	-	-	2	-	150	-	-	17	-	-	-	-	-	3	32
51	-	2	-	-	-	-	-	-	-	-	-	-	-	-	68	-	-	1	-	-	-	-	-	7	37
50	-	-	-	-	-	-	-	1	1	-	-	-	1	-	50	-	-	3	-	-	-	-	-	5	27
49	-	1	-	-	-	-	-	-	1	-	-	-	1	-	50	-	-	1	-	-	-	-	-	7	50
48	-	-	-	-	-	-	-	1	1	3	-	-	1	-	53	-	-	2	-	-	-	-	-	5	20
47	-	1	-	-	-	-	-	1	-	3	-	-	-	-	63	-	-	3	-	-	-	-	-	8	45
46	-	-	-	1	-	-	-	-	1	1	-	-	2	-	55	-	-	2	-	-	-	-	-	9	53
45	-	1	-	-	-	-	-	-	-	6	-	1	-	-	62	1	2	-	-	-	-	-	-	20	79
44	-	-	-	-	-	-	-	-	-	-	-	-	-	-	52	-	-	2	-	-	-	-	-	21	107
43	-	-	-	-	-	-	-	-	-	1	-	-	-	-	18	-	-	2	-	-	-	-	-	10	69
42	1	1	-	-	-	-	-	-	-	-	-	-	-	-	51	-	-	-	-	2	-	-	-	53	337
41	-	2	-	-	-	-	-	-	1	1	-	-	1	-	63	-	1	3	-	2	-	-	-	74	322
40	-	1	-	-	-	-	-	-	-	2	-	-	1	-	35	-	-	2	-	2	-	-	-	68	371
39	-	1	-	-	-	1	-	-	1	2	-	-	-	-	55	-	-	-	-	3	-	-	-	30	281
38	-	-	-	-	-	-	-	-	-	1	-	-	-	-	37	-	-	-	-	-	-	2	1	42	271
37	-	2	1	-	-	-	-	-	3	-	-	-	2	-	32	-	1	-	-	-	-	-	-	29	[illegible]
36	1	-	-	-	-	-	-	-	-	2	-	-	-	-	32	1	-	-	-	1	-	-	-	16	95
35	-	1	-	-	-	-	-	-	1	-	-	-	3	-	69	-	-	2	-	1	-	-	-	29	116
34	1	-	-	-	-	-	-	-	-	1	-	-	1	-	36	-	-	-	-	1	-	-	-	2	22
33	-	-	-	-	-	-	-	-	-	1	-	-	-	-	14	-	-	-	-	-	-	-	-	1	26
32	-	-	-	-	-	-	-	-	-	1	-	-	1	-	33	-	-	-	-	-	-	-	-	10	51
30	-	2	-	-	-	-	-	-	-	1	-	-	2	-	61	-	-	1	1	-	-	-	-	24	79
28	1	2	-	-	-	-	-	-	-	-	-	-	-	-	20	-	-	-	-	-	-	-	-	16	81
26	-	-	-	-	1	-	-	-	-	3	-	-	-	-	23	9	-	1	-	-	-	-	-	18	95
24	1	8	-	-	-	-	-	-	1	2	-	-	-	-	46	-	-	2	-	-	-	-	-	8	35
22	-	1	-	-	-	-	-	-	-	-	-	-	-	-	44	-	-	-	-	-	-	-	-	7	29
20	-	-	-	-	-	-	-	-	-	-	-	-	-	-	14	-	-	-	-	-	-	-	-	22	70
18	-	2	-	-	-	-	1	-	1	-	-	1	-	1	428	-	-	-	-	1	-	2	-	7	42
16	-	4	-	-	1	-	-	-	-	1	-	-	-	-	80	-	-	-	-	2	-	-	-	8	80
14	-	-	-	-	-	-	-	-	-	-	-	-	-	-	21	-	-	-	-	1	-	-	-	5	53
12	-	-	-	-	-	-	-	-	-	1	-	-	-	-	10	-	-	-	-	2	-	-	-	7	64
10	-	-	-	-	-	-	-	-	-	-	-	-	-	-	22	-	-	-	-	-	-	-	-	9	72
8	-	-	-	-	-	-	-	-	-	-	-	-	-	-	28	-	1	-	-	1	-	-	-	14	88
6	1	-	-	-	-	-	-	-	-	2	-	-	-	-	25	-	-	-	-	-	1	-	-	16	86
4	1	1	-	-	-	-	-	-	-	-	-	-	2	-	35	-	-	-	-	-	-	-	-	10	81
3	-	-	-	-	-	-	-	-	-	3	-	-	-	-	35	-	-	-	-	-	-	-	-	11	68
2	-	-	-	-	-	-	-	-	-	4	2	-	1	-	58	-	-	-	-	-	-	-	-	1	141
1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	39	-	-	-	-	-	1	1	-	-	62

Sample No	Polypodium vulgare	Potamogeton sect. Coleog.	Potamogeton sect. Eupotam.	Pteridium aquilinum	Rumex aquaticus/hydrolap.	Selaginella selaginoides	Sparganium type	Sphagnum	Indeterminable	Indeterminate	Coniferae indeterminate	Pinus t. haploxylon	Pterocarya	Taxodiaceae/Cupressaceae	Hystrix	Pediastrum	Slide surface in cm²
52	-	-	-	-	-	-	-	3	2	-	-	-	-	-	-	1	12.2
51	1	-	-	-	-	-	-	-	5	-	-	-	-	-	-	-	9.6
50	-	-	-	-	-	-	-	3	2	2	-	-	-	-	-	-	11.0
49	-	-	-	-	-	-	-	3	1	1	-	-	-	1	-	-	9.3
48	-	-	-	-	-	-	-	2	5	1	-	-	-	-	-	-	8.2
47	1	-	-	-	-	-	-	5	3	1	-	-	-	-	-	-	8.3
46	-	-	-	-	-	-	-	3	3	1	-	-	-	-	-	-	13.4
45	-	-	-	-	-	-	-	7	3	1	-	-	-	-	-	-	10.7
44	-	-	-	-	-	-	-	7	1	1	2	1	-	-	-	-	18.6
43	-	-	-	-	-	-	-	3	3	1	-	-	-	-	-	-	11.0
42	-	-	-	1	-	-	-	8	-	1	1	-	-	-	-	-	13.4
41	2	-	-	1	-	-	-	8	11	2	-	-	1	-	-	-	13.6
40	-	1	-	-	-	-	-	10	9	2	1	-	-	-	-	-	16.0
39	-	1	-	-	-	1	-	5	7	-	1	-	-	-	-	-	9.0
38	-	-	-	1	-	-	-	4	2	1	1	-	-	-	-	-	12.0
37	-	1	-	-	-	-	-	1	2	-	1	-	-	-	1	-	6.0
36	-	-	-	1	-	-	-	9	8	-	-	-	-	-	-	-	8.2
35	-	-	2	2	-	-	-	2	1	-	-	-	-	-	-	1	8.0
34	-	-	-	-	-	1	-	2	8	-	7	4	-	-	1	-	20.0
33	-	-	-	-	-	2	-	-	4	-	15	-	-	-	1	-	21.0
32	-	-	-	-	-	-	-	-	3	1	-	-	-	-	-	-	9.8
30	-	1	-	2	-	-	-	1	2	-	-	-	-	-	-	-	9.4
28	-	-	-	-	-	-	-	1	5	2	-	-	-	-	-	-	15.2
26	-	-	-	-	-	1	-	1	3	-	-	-	-	-	-	-	9.8
24	-	-	-	-	1	-	-	-	1	2	-	-	-	-	-	-	9.4
22	-	1	-	-	-	1	-	1	-	-	-	-	-	-	-	-	10.6
20	-	1	-	1	-	-	1	-	1	-	-	-	-	-	-	-	8.9
18	-	-	1	-	1	-	-	3	9	-	-	-	-	-	-	-	9.8
16	-	-	-	-	-	-	1	1	6	1	-	-	-	-	-	-	11.6
14	-	-	-	1	-	-	-	3	4	-	-	-	-	-	-	-	10.9
12	-	-	-	-	-	-	-	3	3	-	-	-	-	-	-	-	13.4
10	-	-	-	-	-	-	-	1	3	2	-	-	-	-	-	-	13.9
8	-	-	-	-	-	-	-	8	10	2	-	-	-	-	-	-	13.4
6	-	-	-	-	-	-	1	1	14	2	-	-	-	-	-	-	19.0
4	-	-	2	-	-	-	-	4	6	-	-	1	-	-	-	-	15.0
3	-	-	1	-	-	-	-	2	4	1	-	-	-	-	-	-	13.2
2	-	-	4	-	-	-	-	1	7	1	5	-	-	-	-	-	8.4
1	-	-	-	-	-	-	-	1	4	1	12	-	-	-	2	-	9.0

Kąty - Profile II. Absolute numbers of sporomorphs

Kąty - Profil II. Bezwzględne ilości sporomorf

Table 2

Tabela 2

Sample No	Abies	Alnus	Betula t. alba	Betula t. nana	Carpinus	Corylus	Fagus	Hippophaë	Juniperus	Larix	Picea	Pinus cembra	Pinus t. silvestris	Populus	Quercus	Salix	Sambucus cf. racemosa	Sorbus cf. aucuparia	Tilia	Ulmus	AP - sum
48	-	2	6	-	1	-	-	-	2	-	2	3	167	-	-	17	-	-	-	-	200
47	-	1	11	4	-	-	-	-	3	3	5	5	237	1	-	64	-	-	-	1	335
46	-	2	7	2	-	-	-	-	8	3	5	1	384	-	-	43	-	-	-	-	445
45	-	2	5	1	-	-	-	-	3	2	3	-	183	-	-	1	-	-	-	-	200
44	-	-	5	-	-	-	-	-	2	2	6	-	258	1	-	1	-	-	-	-	275
43	-	2	6	-	-	-	-	1	4	2	2	-	180	-	-	2	-	-	-	1	200
42	-	5	3	-	-	-	-	-	4	1	4	-	184	1	-	-	-	-	-	-	202
41	-	5	2	-	-	-	-	-	2	-	7	-	184	-	-	-	-	-	-	-	200
40	-	2	5	-	-	-	-	-	1	4	7	-	197	-	-	-	-	-	-	-	216
37	-	3	4	-	-	-	-	-	1	2	8	1	176	1	-	2	-	1	1	-	200
35	-	2	4	-	1	-	-	-	6	8	29	-	337	-	-	1	2	-	-	1	391
34	-	7	3	-	1	1	-	-	1	3	27	-	157	-	-	-	-	-	-	-	200
32	-	7	2	1	-	-	-	-	2	5	55	3	425	-	-	-	-	-	-	-	500
30	-	7	9	-	-	-	-	-	4	6	38	-	480	-	1	3	-	-	-	1	549
28	-	3	-	-	-	-	-	-	-	1	28	-	267	-	-	1	-	-	-	-	300
26	1	5	4	-	-	1	-	-	-	9	64	-	573	-	-	-	1	-	-	-	658
24	-	6	3	1	-	-	-	-	-	3	26	1	260	-	-	1	-	-	-	-	301
22	-	2	5	1	-	-	-	-	3	3	55	2	429	-	-	1	-	-	-	-	501
21	-	1	4	-	-	-	-	-	1	-	39	2	253	-	-	-	-	-	-	-	300
20	-	1	8	-	2	-	-	-	2	2	59	7	217	-	-	2	-	-	-	-	300
18	-	5	1	1	1	-	-	-	1	3	62	-	175	-	-	1	-	-	-	1	251
16	-	22	7	-	-	-	-	-	1	-	81	3	186	-	-	-	-	-	-	-	300
14	-	26	6	-	1	2	-	-	-	1	187	-	341	-	-	-	1	-	-	-	465
12	-	48	2	-	1	-	-	-	3	-	81	-	65	-	-	-	-	-	-	-	200
10	-	45	3	-	3	-	-	-	1	-	79	-	68	-	1	-	-	-	-	-	200
8	1	12	-	-	1	-	-	-	-	-	136	-	50	-	-	-	-	-	-	-	200
6	3	16	2	-	3	-	-	-	-	2	189	-	74	-	-	-	2	-	-	-	291
4	6	35	-	-	-	3	-	-	-	1	459	-	95	-	-	1	-	-	-	-	600
3	5	72	2	-	4	1	1	-	1	1	777	3	131	-	1	-	-	-	-	1	1000
2	12	71	1	-	3	2	-	-	-	1	319	-	89	-	1	-	-	-	-	1	500
1	24	95	-	-	4	4	-	-	1	1	313	-	55	-	1	-	-	-	-	2	500

Sample No	Anthemis type	Armeria B-line	Artemisia	Bupleurum	Calluna	Campanula	Caryophyllaceae	Centaurea cf. montana	Centaurea t. scabiosa	Cerastium type	Chenopodiaceae	Cirsium type	Compositae Liguliflorae	Compositae Tubiflorae	Cruciferae	Cyperaceae	Elymus	Ericaceae	Geranium	Glechoma type	Gramineae
48	1	1	1	-	-	-	-	1	-	-	-	-	14	3	-	60	-	-	-	-	47
47	-	-	-	-	-	-	-	-	-	-	-	-	11	2	1	64	-	-	-	-	57
46	-	1	2	-	-	-	-	-	-	-	1	-	5	1	-	81	1	-	-	-	71
45	-	-	1	-	-	1	-	-	-	-	1	-	12	1	-	57	-	-	-	-	44
44	-	-	1	-	-	-	-	-	-	-	1	1	15	3	-	82	-	-	-	-	55
43	-	-	-	-	-	-	-	-	-	-	-	-	9	2	-	48	-	1	-	-	48
42	-	-	-	-	-	-	-	-	-	-	-	-	11	2	-	57	-	-	-	-	63
41	-	-	-	-	-	-	-	-	-	-	1	-	10	6	-	34	-	-	-	-	43
40	-	-	-	-	-	-	-	-	-	-	-	-	8	5	-	46	-	-	1	-	51
37	-	-	-	1	-	-	-	-	-	-	-	-	13	4	1	42	-	-	1	-	54
35	-	-	-	-	-	-	-	-	-	-	-	-	10	1	-	38	-	-	-	-	43
34	-	1	-	-	1	-	-	-	-	-	1	-	11	1	1	14	-	-	-	-	28
32	-	-	-	-	1	-	-	-	-	-	-	-	8	3	-	63	1	-	-	-	49
30	1	-	2	-	-	-	-	-	-	1	-	1	15	10	1	35	-	-	-	-	53
28	-	-	-	-	1	-	-	-	-	-	-	-	15	1	-	8	-	-	-	-	29
26	1	-	-	-	-	-	-	-	-	-	-	-	8	-	1	40	-	-	-	-	47
24	-	-	-	-	-	-	-	-	-	-	-	1	3	-	-	7	-	-	-	-	37
22	-	-	-	-	-	-	-	-	-	-	-	-	8	-	-	36	-	-	-	-	37
21	-	-	-	-	-	-	-	1	-	-	-	-	1	2	-	8	-	-	1	-	59
20	-	-	1	-	-	-	-	-	-	-	1	-	-	3	-	4	-	-	-	-	28
18	-	-	-	-	-	-	2	-	-	-	-	-	2	1	-	5	-	-	-	-	25
16	-	-	1	-	-	-	-	1	-	-	-	1	1	2	-	3	-	-	-	-	19
14	1	-	-	-	-	-	-	-	-	-	-	1	9	4	-	4	-	-	-	-	29
12	-	-	-	-	-	-	-	-	1	-	-	-	11	5	-	5	-	-	-	-	23
10	-	-	-	-	-	-	-	-	-	-	1	3	14	4	-	5	-	-	-	-	13
8	-	-	-	-	-	-	-	-	-	-	-	-	3	-	-	1	-	-	-	-	4
6	-	-	-	-	-	1	-	-	-	-	-	-	5	2	-	3	-	-	-	-	9
4	1	-	-	-	-	-	-	-	-	-	-	-	8	4	1	4	-	-	-	1	16
3	-	-	-	-	-	-	-	-	-	-	-	-	3	2	-	12	-	1	-	-	17
2	-	-	-	-	-	-	-	-	-	-	-	-	-	1	-	27	-	-	-	-	12
1	-	-	1	-	-	-	-	-	-	-	-	-	-	-	-	4	-	-	-	-	4

Sample No	Jasione	Mentha type	Papaver	Papilionaceae	Pimpinella type	Plantago lanceolata	Plantago maior	Plantago maritima s.l.	Pleurospermum	Polemonium	Polygonum t. aviculare	Prunella type	Ranunculus t. acer	Rosaceae	Rubiaceae	Rumex sect. Lapathum	Symphytum	Thalictrum	Trollius	Umbelliferae	Valeriana	Veronica type	NAP - sum
48	1	-	-	-	2	-	-	-	-	-	-	-	-	-	-	-	-	3	-	-	-	-	134
47	-	-	-	-	-	-	-	-	-	-	-	-	-	-	3	-	-	-	-	6	-	2	146
46	-	-	-	-	1	-	-	-	-	-	-	-	-	-	3	-	-	-	-	2	1	-	170
45	-	-	-	-	-	-	-	-	-	-	-	-	-	-	4	-	-	-	-	4	-	-	125
44	-	-	-	1	1	-	-	-	1	-	-	-	-	-	5	-	-	-	1	9	-	-	176
43	-	-	-	-	-	-	-	-	-	-	-	-	-	-	3	-	-	-	-	6	-	-	117
42	-	-	-	1	-	-	-	-	-	-	-	-	-	2	5	-	-	-	-	6	-	-	147
41	-	1	2	-	-	-	-	-	-	1	-	-	-	3	2	-	2	1	-	8	-	-	113
40	-	-	-	-	1	-	-	-	-	-	-	-	1	2	3	-	-	1	-	2	-	-	122
37	-	-	-	-	-	-	-	-	-	-	-	-	-	1	-	-	-	-	-	2	-	-	119
35	-	-	-	2	-	1	-	1	-	1	1	1	-	4	2	-	-	2	-	3	1	-	111
34	-	-	-	-	-	-	-	-	-	-	-	-	-	2	2	1	-	-	-	1	-	-	64
32	1	-	-	-	-	-	-	-	-	-	-	2	-	-	2	-	-	-	-	1	-	-	131
30	-	-	-	-	-	-	-	-	1	-	-	-	2	1	1	-	-	-	-	8	-	-	132
28	-	-	-	-	-	-	-	-	-	-	-	-	-	-	1	-	-	-	-	1	-	-	56
26	-	-	-	-	-	-	-	-	-	-	-	-	-	-	1	-	-	-	-	1	-	-	99
24	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	1	-	-	49
22	-	-	-	-	-	-	-	-	-	-	-	-	-	-	1	-	-	-	-	2	-	-	84
21	-	-	-	-	-	-	-	-	-	-	-	-	-	-	1	-	-	-	-	2	1	1	77
20	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	1	2	-	40
18	-	-	-	-	-	-	-	-	-	-	1	-	-	-	-	-	-	-	-	1	-	-	37
16	-	-	-	-	-	-	-	-	-	1	1	-	1	-	-	-	-	-	-	2	-	-	33
14	-	-	-	-	-	-	-	-	-	-	-	-	2	1	-	-	-	-	-	1	-	-	52
12	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	1	-	-	46
10	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	1	-	1	-	-	42
8	-	-	-	-	-	-	1	-	-	-	-	-	-	-	-	-	-	-	-	-	1	-	10
6	-	-	-	-	-	-	-	-	-	-	-	-	1	-	2	-	-	1	-	2	1	-	27
4	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	1	-	-	36
3	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	1	-	1	37
2	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	40
1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	9

Sample No	Botrychium	Caltha type	Lycopodium annotinum	Lycopodium clavatum	Lycopodium compl./trist.	Lycopodium selago	Phegopteris dryopteris	Polypodiaceae	Polypodium vulgare	Potamogeton sect. Coleog	Potamogeton sect. Eupotam	Pteridium aquilinum	Selaginella selaginoides	Sparganium type	Sphagnum	Typha latifolia	Indeterminable	Indeterminate	Coniferae indeterminate	Pinus t. haploxylon	Pediastrum	Slide surface in cm^2
48	2	1	-	-	-	-	2	18	1	-	-	-	1	-	-	-	1	1	-	-	-	9.6
47	4	1	-	-	-	1	2	19	-	-	-	-	-	-	8	-	1	-	-	-	-	6.4
46	1	-	-	-	-	-	-	12	-	-	-	-	-	-	6	-	5	-	-	-	-	6.4
45	-	-	-	-	-	-	-	7	-	-	-	-	-	-	-	-	1	1	-	-	-	6.4
44	-	1	-	-	-	-	8	21	-	-	-	-	-	-	4	-	1	-	-	-	-	6.4
43	1	2	-	-	-	-	-	15	-	-	-	1	-	-	8	-	2	1	-	-	-	7.9
42	-	1	-	-	-	-	1	25	-	-	-	-	-	-	7	-	2	-	1	-	-	6.4
41	-	1	-	-	-	-	3	18	-	-	-	-	-	-	7	-	-	-	-	-	-	7.2
40	-	1	-	-	1	-	3	31	-	-	-	-	-	-	2	-	-	-	-	-	-	6.4
37	-	2	-	-	1	-	7	65	-	-	-	-	-	-	7	-	1	-	-	-	-	9.1
35	-	-	-	-	-	1	1	19	-	-	-	-	-	-	7	-	4	-	-	-	-	6.4
34	-	2	-	-	-	-	2	26	-	-	-	-	-	-	2	-	-	-	-	-	-	6.7
32	-	2	-	-	-	-	6	8	-	-	-	-	-	-	-	-	1	1	-	-	-	5.8
30	-	3	3	-	-	-	11	70	-	-	-	-	-	-	3	-	-	1	-	-	-	6.4
28	-	2	-	-	-	-	3	22	-	-	-	-	-	-	1	-	-	-	-	-	-	6.3
26	2	4	-	-	-	-	11	19	-	-	-	-	-	-	3	1	-	-	-	-	-	4.8
24	-	-	-	-	-	-	2	17	-	-	-	-	-	-	4	-	2	-	-	-	-	7.1
22	-	3	-	-	-	-	8	13	-	-	1	-	-	-	-	-	-	-	-	-	-	9.3
21	-	5	-	-	-	-	4	9	-	-	-	-	-	-	1	-	1	-	-	-	-	9.1
20	-	1	-	-	-	-	4	16	1	-	-	-	-	-	1	-	2	-	-	-	-	11.8
18	-	-	-	-	-	-	2	12	-	-	-	-	-	-	-	-	-	-	-	-	-	9.4
16	-	-	-	-	-	-	2	15	-	-	1	-	-	-	-	-	-	1	-	-	-	6.4
14	-	-	-	-	-	-	7	28	-	-	-	-	-	-	5	-	3	-	-	-	-	6.4
12	-	-	-	-	-	-	5	36	-	-	-	1	-	1	3	-	-	-	-	-	-	11.8
10	-	1	-	-	-	-	36	105	-	-	-	-	-	-	3	-	-	-	-	-	-	8.9
8	-	-	-	-	-	-	23	114	-	-	-	-	-	-	-	-	1	-	-	-	-	16.8
6	-	2	-	-	-	-	32	127	-	-	-	-	-	-	2	-	-	-	-	-	1	6.4
4	-	-	-	-	-	-	22	50	-	-	-	-	-	-	-	-	1	-	-	-	-	8.0
3	-	-	1	-	-	-	40	126	1	1	2	1	2	-	4	-	10	-	1	-	-	8.5
2	-	-	1	1	-	-	4	47	-	-	1	-	-	-	3	-	2	1	-	4	-	9.6
1	-	1	-	1	-	-	6	56	-	-	-	-	-	-	1	-	-	-	-	-	-	9.8