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# RESULTS OF PALAEOBOTANICAL STUDIES OF INTERGLACIAL SEDIMENTS FROM GOLASOWICE (RYBNIK PLATEAU, S. POLAND)

Wyniki badań paleobotanicznych osadów interglacjalnych z Golasowic na Płaskowyżu Rybnickim, płd. Polska

WOJCIECH GRANOSZEWSKI

W. Szafer Institute of Botany, Polish Academy of Sciences, Department of Palaeobotany, Lubicz 46, 31-512 Kraków, Poland

ABSTRACT. The results of a palaeobotanical studies (pollen, macroscopic and wood remain analyses) of interglacial sediments from a sand-pit at Golasowice (Rybnik Plateau, Silesian Upland, S. Poland) are presented. The picture of changes in the vegetation implies the decline of an interglacial. A discussion based on palynostratigraphic criteria permits the author to suggest the Eemian age of the sediment examined.

KEY WORDS: pollen analysis, palynostratigraphy, plant macroscopic remains, wood remains, Eemian, Vistulian

## SITE

The study material comes from the Golasowice sand-pit, situated at an altitude of 256 m a.s.l. on the Rybnik Plateau, Silesian Upland (Fig. 1).

The topography of the site of the profile examined suggests that it is a part of a hollow worked out in the bottom of an area lying low in relation to the water-level in the main river (Vistula?). It is a sort of old river-bed with a sluggish flow of water. This type of old river-bed is also encountered now, e.g. on wet river terraces close below a water outflow, in the form of a bog-spring extending to the place where the stream empties into the main river. The depression in which the sediments were deposited at Golasowice is connected with the type of the relief remaining after the Warta Glaciation (acc. to J. M. Waga's information).

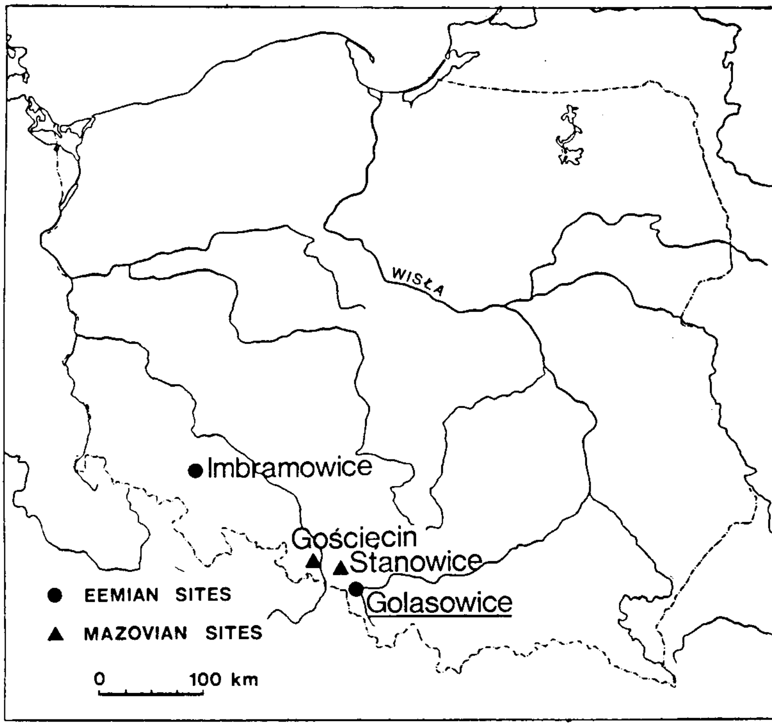


**Fig. 1.** Location of Golasowice and other sites discussed in the text

## LITHOLOGY

The profile comes from an organic layer covered by a two-metre-thick layer of loess formation (loess loam):

2.05–2.12 m grey dusty silt
2.12–2.18 m steel-grey dusty silt
2.18–2.38 m light-brown dusty silt
2.38–2.75 m dark-brown silty gyttja
2.75–2.83 m reed-swamp peat, silty, at top laminated
2.83–3.60 m dark-brown silty swamp peat
3.60–3.63 m sand/orstein

Samples for palaeobotanical analysis were collected by K. Mamakowa (IB PAScs, Kraków), J. Jersak and J. M. Waga of the Laboratory of Palaeogeography and Lithology of Quaternary, Sil. Univ. at Sosnowiec. Lately, the author of this paper received them for study. The sediments studied by pollen and macrofossils analyses ranged between depths of 3.60 and 2.10 m.

## METHODS

Samples designed for pollen analysis were boiled in 10% KOH and treated with hot hydrofluoric acid prior to the application of Erdtman's acetolysis.

Pollen spectra from each sample were counted on two slides. They were always counted all over the surface of the slide, the traverses being compressed according to the frequency of pollen. The tree pollen sum fluctuated from 500 to above 1000 grains. The total sum (=basic), on which the percentage calculations were based, consists of tree, shrub and terrestrial herb pollen. The percentage values of aquatics, reed-and-rush swamp vegetation (local) and spores of *Pteridophyta*, *Sphagnum* and *Bryales* were counted in relation to the basic sum increased by the respective taxon. The results are given in a pollen diagram (Fig. 2).

From each sample 100 ccm of deposit was used for macroscopic analyses. The deposit was boiled in water with an addition of a several-percent solution of KOH and rinsed on 0.2 and 0.5 mm mesh sieves. In the course of rinsing a little detergent (dish-washing fluid) was added; next the remains were picked out and placed in glycerine mixture. The full assemblage of plant macrofossils determined are presented in a diagram (Fig. 3) and in the table 1 (wood and charcoal remains).

## RESULTS

### Local pollen zones (Fig. 2)

The behaviour of the curves for various taxa allowed the distinction of two local pollen zones (L PAZ).

Lower pollen zone GP-1 *Pinus-Betula-Alnus* (3.60–2.98 m) – is characterized by a very high proportion of tree pollen (above 80%). The highest values (35–40%) are reached by *Pinus sylvestris* type pollen; tree-birches occur in relatively high percentages. On the other hand, these values of *Alnus, Carpinus, Picea* and *Abies* are significant but have a distinct downward tendency. *Betula nana* attains a little above 1%. Thermophilous leaved tress – *Fraxinus, Quercus, Acer, Ulmus* and *Corylus* – have their pollen in trace quantities here and there are sporadic pollen grains of *Hedera* and *Vitis*.

Out of the herbaceous plants the *Cyperaceae* reach the highest values (18%), the *Gramineae* somewhat lower (9%).

Upper pollen zone GP-2 *Gramineae-Artemisia-Juniperus* (2.98–2.10 m) – is distinguished by a considerable and consistent rise in the pollen values of herbs, to 42%. *Cyperaceae* has the highest value but with a downward tendency. The percentages of *Gramineae*, *Ericaceae* undiff., *Artemisia, Thalictrum* and *Umbelliferae* are distinctly on the increase. As regards trees, the values of *Pinus sylvestris* type remain around 30%, *Betula* undiff. to 22%, whereas the percentages of *Alnus, Carpinus, Picea abies* and *Abies* are evidently decreasing. The proportions of *Larix* and *Juniperus* are increasingly high.

The boundary between the zones described above is marked by the fall in the pollen values of *Alnus, Carpinus, Picea* and *Abies* and the increase of the NAP, *Juniperus* and *Larix* values. It is at the same time the boundary between the interglacial and the glacial vegetational succession.

## Local macrofossil zones (Fig. 3 and Tab. 1)

**Table 1.** Wood and charcoal remains. figure – number of fragments; c – charcoal

| Depth cm | *Alnus* sp. | *Betula* sp. | *Pinus* sp. | *Salix* sp. | *Fraxinus* sp. | *Picea/Larix* | *Corylus avellana* | *Acer* sp. | Indeterminable |
|---|---|---|---|---|---|---|---|---|---|
| 251–256 | | | 2 | | | | | | |
| 256–260 | | | 1 | | | | | | 2 |
| 266–271 | | | 1 | | | | | | 12 |
| 291–296 | 1 | 3 | 1 | | | 1 | | 1c | 5 |
| 301–306 | 1 | | 1 | | | | | | 5 |
| 306–310 | 4 | 2 | 1 | 1 | | | | | 2 |
| 311–316 | | | 1 | | | | 3 | | 6 |
| 316–321 | | | | 1 | | | | | 10 |
| 321–326 | 1 | | | | | | 6 | | 9 |
| 326–331 | | 1c | | | 1c | 1c | | | |
| 331--336 | 4 | 1c | | | | | | | 2 |
| 336–341 | 1 | 1 | 1 | 2 | | | | | 2 |
| 341–346 | 7 | | | | | | | | |
| 346–351 | 2 | 3 | 2 | 4 | | | | | 5 |
| 351–356 | 5 | | 1 | | | | | | 3 |
| 356–361 | 3 | 4 | | | | | | | 11 |

Three zones can be distinguished in the diagram of plant macrofossils.

In the lower zone GM-1 (3.61–3.01 m), including macrofossil samples 2–13, the distinct numerical predomination of birch remains from the sect. *Nanae* over those from the sect. *Albae* is a characteristic feature. There are remains of a number of plants no longer present in the upper part of the profile, e.g. *Rubus idaeus, Scirpus lacustris, S. mucronatus* (Pl. 1), *Sparganium* sp., *Iris* sp., *Hippuris vulgaris* and others. The proportion of *Carex* sp. div. is rather high.

Middle zone GM-2 (2.96–2.66 m) contains macrofossil samples 14–17. It is characterized by a marked quantitive prevalence of remains of tree birches (sect. *Albae*) over those of the sect. *Nanae*. A number of plants have their maxima in this zone. These are:

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**Fig. 2.** Pollen diagram from Golasowice. 1 – sand, 2 – dark-brown swamp peat, 3 – silt, 4 – reed- swamp peat, 5 – gyttja


GOLASOWICE
TREES AND SHRUBS
HERBS AND DWARF SHRUBS
REEDSWAMPS AND AQUATICS
PTERIDOPHYTA
BRYOPHYTA
FOREST HABITATS
VARIOUS HABITATS
OPEN, DRY HABITATS
OPEN, FRESH TO WET HABITATS
LITHOLOGY
DEPTH cm
POLLEN SAMPLES
AP
NAP
POLLEN SUM
Pinus sylvestris t.
Betula undiff.
Ulmus
Quercus
Fraxinus
Corylus
Taxus
Tilia
Acer
Fagus
Frangula alnus
Buxus
Ilex
Rhamnus
Sambucus
Alnus
Carpinus
Picea abies
Abies alba
Larix
Populus tremula t.
Juniperus
Salix
Betula nana
Calluna vulgaris
Viola riviniana
Humulus
Empetrum
Glechoma t.
Gramineae
Cyperaceae
Ericaceae undiff.
Chenopodiaceae
Rubiaceae
Asteroideae undiff.
Cichorioideae
Caryophyllaceae undiff.
Rosaceae undiff.
Umbelliferae undiff.
Cruciferae
Artemisia
Gypsophila t.
Helianthemum nummularium t.
Sagina
Arenaria t.
Anemone t.
Spergularia
Dryas octopetala
Scleranthus perennis
Thalictrum
Potentilla t.
Ranunculus acris t.
Polygonum bistorta/viviparum
Sanguisorba officinalis
Rhinanthus t.
Lysimachia nummularia
Achillea t.
Veronica
Rumex acetosa t.
Melampyrum
Plantago lanceolata
Valeriana
Senecio t.
Solidago t.
Campanula t.
Lotus
Urtica
Alchemilla t.
Polygonum aviculare t.
Bellis t.
Geum
Plantago major/media
Plantago maritima s. str.
Gentiana pneumonanthe t.
Polemonium
Aster t.
Cirsium t.
Lychnis t.
Ranunculus flammula t.
Menyanthes trifoliata
Caltha t.
Filipendula
Comarum
Pedicularis
Ledum palustre
Viola palustris
Lysimachia thyrsiflora
Sparganium t.
Typha latifolia
Hydrocotyle vulgaris
Triglochin
Scheuchzeria palustris
Eupotamogeton
Utricularia
Nuphar
Coleogeton
Polypodiaceae undiff.
Osmunda cinnamomea
Equisetum
Polypodium vulgare
Lycopodium clavatum
Botrychium
Sphagnum
Bryales
LOCAL POLLEN ZONES
CHRONOSTRATIGRAPHY
GRAMINEAE-ARTEMISIA -JUNIPERUS
PINUS-BETULA -ALNUS
VISTULIAN
EEMIAN
Hedera
Vitis
210
220
230
240
250
260
270
280
290
300
310
320
330
340
350
360
12
11
10
9
8
7
6
5
4
3
2
1
861
1434
1685
1519
1660
1251
1269
1151
1211
1307
1531
1682
50
20
20
5
10
10
5
10
1
2
3
4
5
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*Menyanthes trifoliata, Comarum palustre, Potentilla* sp., *Lycopus europaeus, Urtica* sp., *Typha* sp., *Schezcheria palustris* (Pl. 1). Out of the sedges the remains of *Carex vesicaria / rostrata* and *C.* cf. *elata* occur in abundance.

Top zone GM-3 (2.66–2.11 m) embraces samples 18–27. It is very poor in plant macrofossils. Its characteristic feature is the presence of *Selaginella selaginoides* macrospores.

## DESCRIPTION OF VEGETATION

On the basis of the pollen and macrofossil diagrams an attempt was made to reconstruct the changes in the regional vegetation and the picture of the strictly local vegetation.

Pollen assemblage GP-1 indicates the dominance of pine-birch forest at that time. The very abundant occurrence of nuts and fruit scales of *Betula humilis* and *B. nana* (Pl. 1) in zone GM-1, accompanied by the trace presence of tree-birch remains, suggests however that *Betula* undiff. pollen represents here not only tree birches but also *B. humilis* and, partly *B. nana*, for the pollen curve of this last taxon reflects the presence of only very characteristic grains. These data indicate that the proportion of tree birches must have been much smaller in the composition of the regional forest vegetation than it might be inferred from the values of *Betula* undiff. pollen. And so during the formation of the *Pinus-Betula-Alnus* zone there were pine forests with a small addition of birch in this area. It seems that the presence of *Betula humilis* and *B. nana* remains should be regarded as indicative of local relict stand of these species closely connected with the habitat. The relatively high percentages of *Carpinus* in the course of the *Pinus-Betula-Alnus* zone allow the assumption that in the Golasowice region there may have been oak-hornbeam forests with single limes and maples. No doubt they were regressive communities in their declining phase. The higher-situated habitats were occupied by spruce-fir woodlands, perhaps with single beech-trees.

In the close vicinity of the water body there was undoubtedly a large mosaic of habitats and plants communities. Swamp forests with dominant *Alnus glutinosa* (macrofossils) and/or thickets of broad-leaved willows, alder and alder buckthorn (*Frangula alnus*), *Spiraea salicifolia* (Pl. 1) and perhaps with the presence of *Betula humilis* most probably grew here. The numerous nutlets of *Carex* sp. div. and towards the top of the zone the increase of the number of nutlets of *Carex vesicaria / rostrata* indicate the development of tall sedgeswamps.

In the course of the upper, *Gramineae-Artemisia-Juniperus* pollen zone a number of essential changes take place in both the regional and the local vegetation. The rapid drop in the pollen values of *Carpinus, Alnus, Picea abies* and *Abies* correlated with the increase of those of *Betula* undiff., *Larix, Juniperus* and herbaceous plants, evidences a radical transformation of the forest communities and their open nature. At that time the oak-hornbeam, spruce-fir and alder communities probably underwent a total degradation and decline. The increase of the proportion of *Betula* undiff. pollen, accompanied by the rise in the number of macrofossils of birches from the sect. *Albae*, suggests an increasing role of birch in the pine-birch communities. In all probability, this part of the profile indicates the formation of a zone of an open boreal pine-birch forest with larch, single spruces, stands of juniper and different types of developing herbaceous communities. The high *Cyperaceae* curve and large numbers of macrofossils of *Carex vesicaria / rostrata*, *C.* cf. *elata, Scirpus lacustris, S. mucronatus, Sparganium* sp., *Eleocharis* sp. and others point to an intense development of tall-sedgeswamps. Here there are also macrofossils of species, which would indicate the occurrence of moss-sedge swamp communities, mainly low-sedge fens, e.g. *Schezcheria palustris, Comarum palustre, Triglochin palustre* and *Menyanthes trifoliata.*

The presence of wet meadows may be evidenced by the pollen of *Polemonium, Gentiana pneumonanthe* type and *Rumex*, whereas the existence of open dry communities by the rise in *Artemisia, Gramineae* and *Ericaceae* undiff. pollen. The occurrence of *Dryas octopetala, Scleranthus perennis* pollen and *Selaginella selaginoides* macrospores suggests the worsening of the climate and the expansion of open habitats.

## STRATIGRAPHY

The changes of vegetation reconstructed on the basis of the both diagrams presented seem to indicate that this profile covers the decline of an interglacial and the first post-interglacial cooling. It is however hard to determine the stratigraphical position of deposits under study unambiguosly. Four types of interglacial succesions have been recently distinguished on the palynological basis in Poland (Janczyk-Kopikowa 1991a, b): Ferdynandów, Mazovian, Zbójno and Eemian Interglacials.

In the case of the Golasowice diagram the Ferdynandów Interglacial can be relatively easily rouled out. For in the pollen succesion of that interglacial there is no zone with simultaneously high values of *Carpinus* and *Abies* pollen. In the lower optimum of that interglacial there is no pollen at all of *Carpinus* or at the most its grains occur sporadically, whereas the pollen values of *Abies* are relatively high. In the upper optimum the proportion of *Carpinus* pollen is high, while the *Abies* pollen is sporadic or lacking entirely. Moreover, at the decline of both these climatic optima of that interglacial the percentages of *Ulmus, Quercus* and *Corylus* are higher than at Golasowice.

The Zbójno Interglacial may be excluded on the basis of the behaviour of the *Carpinus* curve. At the decline of that interglacial the values of *Carpinus* pollen are very small. They do not reach such a high level as that at Golasowice, even at the climatic optimum (see Lindner & Brykczyńska 1980).

The exclusion of the Mazovian and Eemian Interglacials is difficult in the case of the Golasowice sediments, because the final parts of these interglacials have very much in common as regards the pollen succession.

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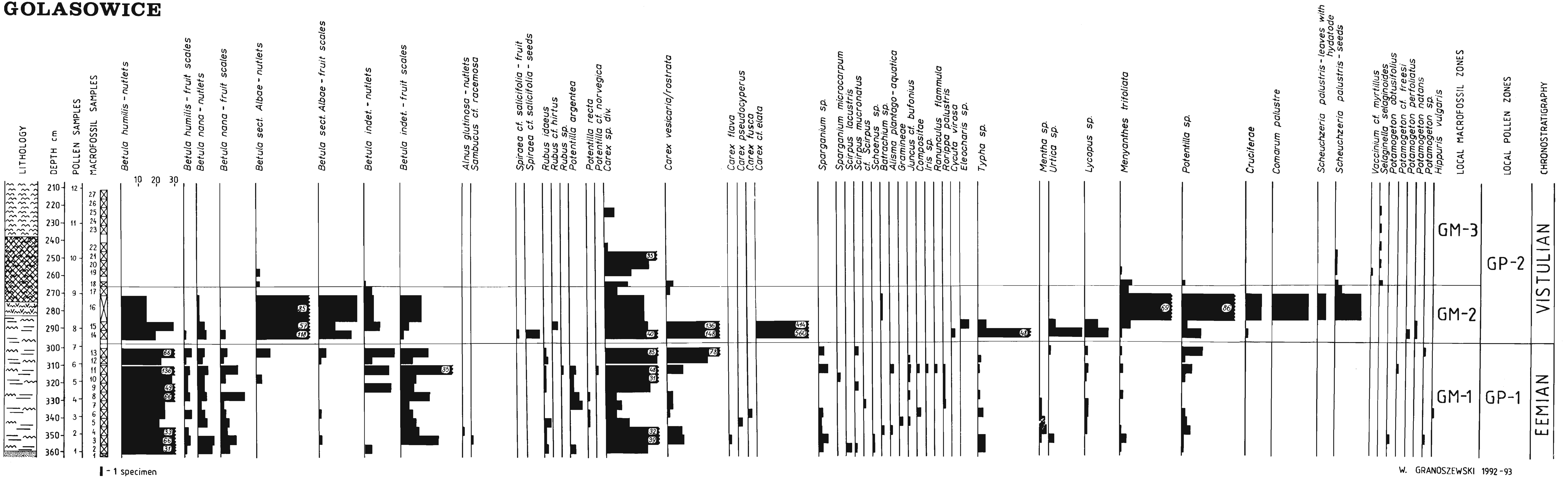
**Fig. 3.** Macrofossil diagram from Golasowice. Lithology as in the Fig. 2


GOLASOWICE
LITHOLOGY
DEPTH cm
POLLEN SAMPLES
MACROFOSSIL SAMPLES
Betula humilis - nutlets
Betula humilis - fruit scales
Betula nana - nutlets
Betula nana - fruit scales
Betula sect. Albae - nutlets
Betula sect. Albae - fruit scales
Betula indet. - nutlets
Betula indet. - fruit scales
Alnus glutinosa - nutlets
Sambucus cf. racemosa
Spiraea cf. salicifolia - fruit
Spiraea cf. salicifolia - seeds
Rubus idaeus
Rubus cf. hirtus
Rubus sp.
Potentilla argentea
Potentilla recta
Potentilla cf. norvegica
Carex sp. div.
Carex vesicaria/rostrata
Carex flava
Carex pseudocyperus
Carex fusca
Carex cf. elata
Sparganium sp.
Sparganium microcarpum
Scirpus lacustris
Scirpus mucronatus
cf. Scirpus
Schoenus sp.
Batrachium sp.
Alisma plantago - aquatica
Gramineae
Juncus cf. bufonius
Compositae
Iris sp.
Ranunculus flammula
Rorippa palustris
Cycuta virosa
Eleocharis sp.
Typha sp.
Mentha sp.
Urtica sp.
Lycopus sp.
Menyanthes trifoliata
Potentilla sp.
Cruciferae
Comarum palustre
Scheuchzeria palustris - leaves with hydatode
Scheuchzeria palustris - seeds
Vaccinium cf. myrtillus
Selaginella selaginoides
Potamogeton obtusifolius
Potamogeton cf. freesi
Potamogeton perfoliatus
Potamogeton natans
Potamogeton sp.
Hippuris vulgaris
LOCAL MACROFOSSIL ZONES
LOCAL POLLEN ZONES
CHRONOSTRATIGRAPHY
10 20 30
GM-3
GM-2
GM-1
GP-2
GP-1
VISTULIAN
EEMIAN
| - 1 specimen
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The younger part of the Mazovian Interglacial is characterized by the hornbeam-fir zone, usually with a large addition of alder pollen, spruce being present in this zone but curve behaves in different ways. *Pterocarya* is often but not always noted in this part.

The younger part of the Eemian Interglacial is characterized by the spruce-fir-alder (*Picea-Abies-Alnus*) zone, but the percentages of hornbeam are relatively high in this zone at many Eemian sites (Mamakowa 1989).

Alder, hornbeam, fir and spruce pollen attains relatively high values at the decline of the interglacial of Golasowice, which makes the conclusive determination of the age of these sediments impossible.

The Mazovian interglacial sites located nearest to Golasowice are Gościęcin (Środoń 1957) and Stanowice (Sobolewska 1977). The final part of the interglacial is lacking in the Gościęcin profile. As for the diagram from Stanowice, we are struck by the exceptionally high values of *Abies* pollen, exceeding the values of *Carpinus* by many times, and the continuous occurrence of *Pterocarya* and *Celtis*.

These features make up the premise that suggests the exclusion of Mazovian age for the Golasowice sediments.

A comparison of the diagram from Golasowice with the final part of the Eemian interglacial at the nearest site of this age at Imbramowice (Mamakowa 1989) shows that the behaviour of the pollen curves for the trees under discussion, i.e. *Alnus, Carpinus, Abies* and *Picea*, is very similar.

The foregoing comparisons therefore speak in favour of the Eemian and not the Mazovian age of the sediments from Golasowice. The dating of the sediments that underlie the organic sediments by the thermoluminescence method could render this determination more precise.

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# PLATES

## Plate 1

1. *Betula nana* – fruit scale, × 10
2. *B. humilis* – fruit scale, × 10
3. *B.* sect. *Albae* – fruit scale, × 10
4. *B. humilis* – nutlet, × 10
5. *Scirpus mucronatus* – fruit (achene), × 10
6. *Spiraea* cf. *salicifolia* – fruit (a group of follicles)

7a. *Schezcheria palustris* – seed, × 10

7b. *Schezcheria palustris* – seed, × 10

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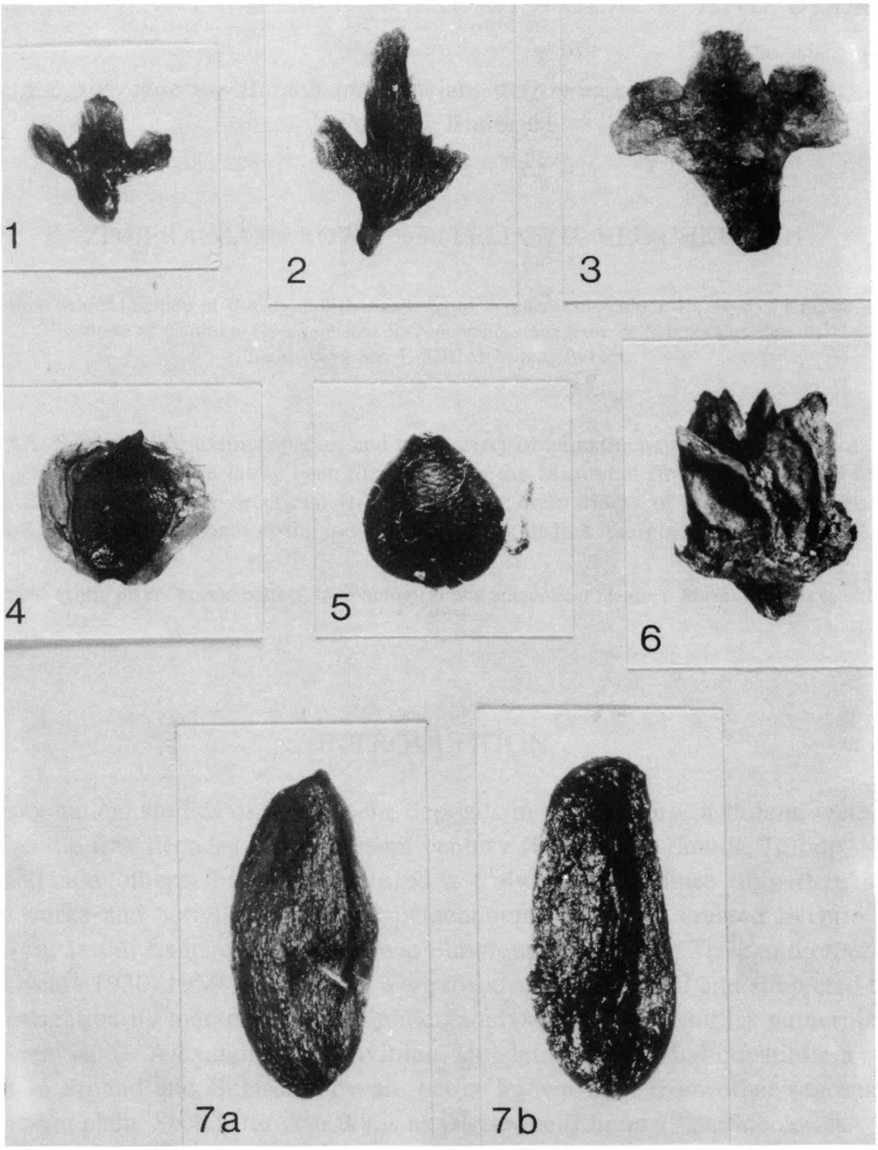
1
2
3
4
5
6
7a
7b