ACTA SOCIETATIS
BOTANICORUM POLONIAE
Vol. XXXI — Nr 2
1962

Pollen analysis of the surface samples of bottom sediments in the bay of Gdańsk

Analiza pyłkowa prób powierzchniowych osadów dennych Zatoki Gdańskiej

K. LUBLINER-MIANOWSKA

The Laboratory of Marine Geology in the Oceanographic Institute at Gdynia is dealing with the postglacial history of South-Baltic shore. From the end of 1960 these investigations were extended by the palynological analyses of the sea bottom sediments. By using the palynological method we are able to determine the age of the sediments strata and to correct sometimes our observations of the ancient shorelines.

As a preliminary investigations a series of samples collected from the surface of bottom sediments in the Bay of Gdańsk were analysed palynologically. These samples, which give the pollen spectra of contemporary flora could serve for a comparision of the pollen deposited on the sea-bottom with the vegetation of the shores surrounding the investigated area.

METHODS

The samples of the sea-bottom were taken primarily by use of Petersens bottom-grab, and later with a short corer (1 m long) which by its own weight goes deep into the bottom. The comparison of samples taken from the same place by the two mentioned tools has shown no differences. Afterwards, all the samples were taken only with a corer. The samples, 10 g of weight, were prepared for the pollen analysis by a flotation method, after the dissolving of $CaCO_3$ by 10% HCl. As a heavy liquid for the flotation the solution of $ZnCl_2$ in water (sp. gravity 1,90) was used.

The organic residue was collected on a filter and treated by the acetylose method according to Erdtmann (1943).

For obtaining a pollen spectrum 1000 grains were counted, AP and NAP together in each sample. Only in a few samples, less rich in pollen, the number of counted grains was 500. Apart from this number also the secondary pollen and *Sphagnum* spores were counted.

The number and distribution of samples

The samples were taken along some lines, running across the Bay of Gdańsk, namely:

I.	Gdynia — Hel	10	samples
II.	Jastarnia — Depth of Gdańsk	8	„
III.	Górki — „ „ „	15	„
IV.	Skowronki — „ „ „	22	„
V.	Piaski — „ „ „	11	„ (see fig. 1)

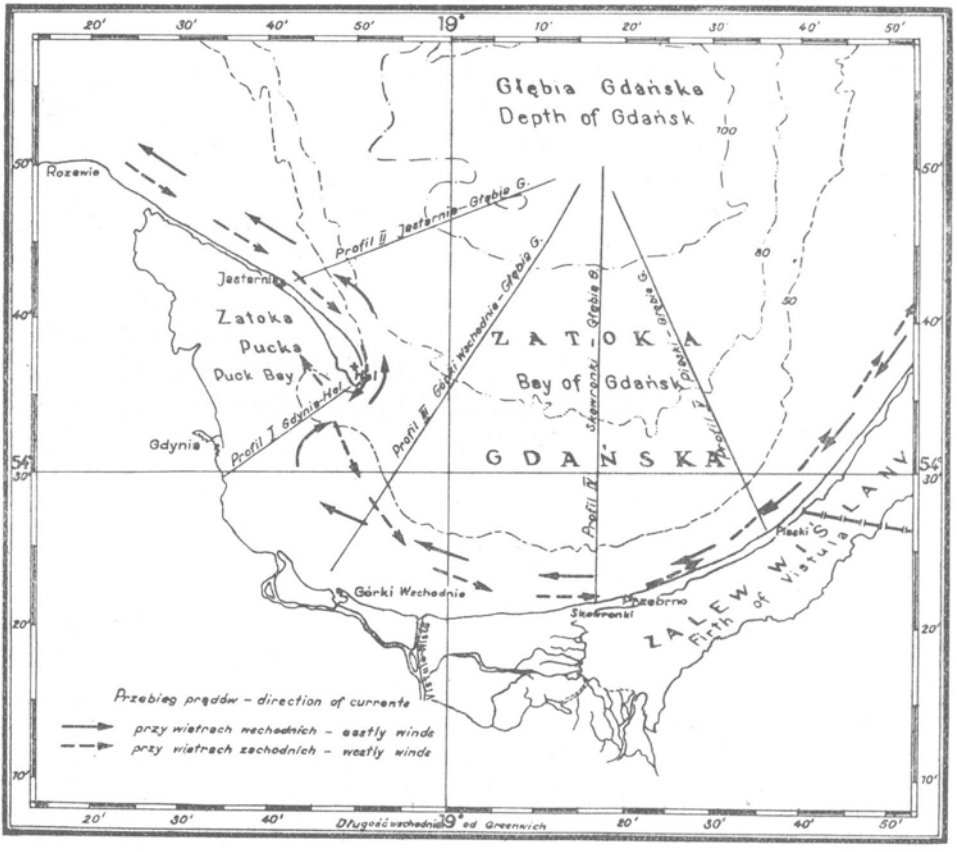

Fig. 1

As can be seen on the map, the space between lines III and IV is wider, than between the others. This was done purposely to leave out the drift of Vistula, as this contains a sandy material, not useful for

pollen analysis. This material may also contain the pollen brought by the river from distant areas. The samples from the sandy zone near the shore were very poor in pollen grains: less than 100 grains in 10 g sample. Pollen is here washed out by the movement of the waves, and together with the lighter mineral grains, carried to the deeper part of the bay, forming the muddy sediments there. The latter have a very abundant pollen material: more than 500, and often some thausands of pollen grains in 10 g sample.

THE RESULT OF POLLEN ANALYSIS

The counted pollen spectra were combined together in 5 groups, according to their situation in relation to the isobathes, namely:

1.	Samples derived from the depth below 20 m . . .	5 samples
2.	Samples derived from the depth from 20 m to 50 m	8 „
3.	Samples derived from the depth from 50 m to 80 m	18 „
4.	Samples derived from the depth from 80 m to 100 m	12 „
5.	Samples derived from the depth greater than 100 m	12 „
	together	55 „

An average pollen spectrum was calculated for each group of samples: the results are seen in table No. 1.

The use of average values is acceptable, because the differences in the pollen percentage for each kind of pollen were not significant. For instance the pollen of *Pinus* was always between 30 and 50%, pollen of *Alnus* below 20%, that of *Picea* from 2 to 6%, that of *Fagus* not higher than 2% etc.

Non arboreal pollen and spores were determined, according to possibility as far as species, genus or family. The NAP sporomorphs were found in small numbers (generally less than 2%). I thought it advisable to combine the average NAP values for some groups, marking the plant-communities which have produced this pollen.

1. The group of shrubs contains the species of *Rhamnus, Cornus, Viburnum, Ligustrum, Ribes, Hippophaë*. Some of these species, like *Hippophaë* grows on the cliffy shores of the bay, the others probably only in gardens of the settlements. The average percentage of shrubs is insignificant (0,02—0,04%).

2. The vegetation of sand-dunes. The most common plants of the sandy shores are *Gramineae*, namely *Elymus* and *Ammophila* species with bigger pollen grains, and *Festuca, Calamagrostis* and *Corynephorus* with smaller ones. All the Grasses were regarded as a dune vegetation. The second dune species is *Artemisia*. It is also possible to find the pollen of *Artemisia* among the synanthropic species, but *Artemisia cam-*

Table 1

Table of mean pollen spectra of the surface samples of bottom sediments in the Bay of Gdańsk

Deepth	*Pinus*	*Betula*	*Salix*	*Picea*	*Corylus*	*Ulmus*	*Quercus*	*Tilia*	*Alnus*	*Carpinus*	*Fagus*	*Fraxinus*
Below 20 m	38,7	22,2	0,2	2,0	2,0	1,1	1,2	1,0	14,6	1,1	0,9	
20 — 50 m	45,5	10,9	0,08	1,6	3,2	1,1	0,7	1,0	11,5	0,3	0,5	
50 — 80 m	45,0	8,0	0,07	3,6	2,6	0,82	0,7	0,7	9,3	0,5	0,6	0,02
80 — 100 m	43,2	11,3	0,1	3,5	2,2	0,8	1,0	0,4	9,8	0,8	0,6	0,02
Above 100 m	47,5	12,5	0,05	4,6	2,7	0,8	1,1	0,4	11,1	1,1	0,5	

Deepth	*Juglans*	*Abies*	Total of AP	Total of NAP	Shrubs	Sand-dune vegetation	Spores	Synanthropic vegetation	Water and moor vegetation	Various	Indeterminated
Bellow 20 m			85,0	15,0	0,3	2,8	3,2	5,6	0,4	2,0	0,7
20 — 50 m		0,08	76,46	23,54	0,2	2,56	13,3	4,3	0,4	1,9	0,8
50 — 80 m		0,07	72,97	27,03	0,16	2,62	17,2	4,53	0,52	1,3	0,7
80 — 100 m	0,02	0,02	73,76	26,24	0,04	3,66	13,01	6,3	0,6	1,8	0,82
Above 100 m		0,05	82,4	17,6	0,06	3,5	4,6	5,45	0,45	2,84	0,7

pestris (sometimes subsp.*maritima*) grows in abundance on the dunes around the Bay of Gdańsk.

3. The group of spores represent sensu stricto the forest vegetation. This group contains the spores of *Polypodium, Pteridium, Dryopteris, Athyrium, Lycopodium.* Except the very rarely found spores of *Equisetum,* all these spores derive from forests.

4. The group of synanthropic plants contains: 1° the pollen of cultivated plants, such as *Cerealia* (mostly *Secale cereale*), *Fagopyrum, Papaver*, and 2° the weeds: species of *Plantago, Rumex, Chenopodium, Polygonum* and *Centaurea cyanus.* This group occurs in 4,3 to 6,3%.

5. Water and moor vegetation. Here belongs the species of *Nymphaea, Nuphar, Menyanthes, Myriophyllum, Sparganium, Typha, Carex, Triglochin, Galium.* This group is of a little significance, no more than 1%.

6. Group of various species contains pollen grains determined only to the family. In such cases we cannot state even approximately the provenience of this sporomorphs. Its amount is from 1,3 to 3,8%.

7. The group of indefinite pollen grains we found in amounts less than 1%.

Finally we shall compare the average pollen spectra found in sediments lying on different depths of the sea (Table 1).

I. AP (Pollen of trees)

As we see the percentage of different genera of trees pollen always lie within the same value class. The most striking difference between these spectra is the increase of percentage of coniferous pollen, with simultaneous decrease od deciduos tree pollen, when going from the shore region of the bay towards the depth of Gdańsk. This is most distinctly seen in the spectra of most numerous genera (*Betula, Alnus*), but the less numerous ones also show slight differences. This phenomenon is no doubt caused by the structure of coniferous pollen, which is better fitted for swimming on the sea surface, and can be more easily transported to the depth.

Higher than the other percentages of *Betula* and *Alnus* pollen are not only caused by the more abundant production of pollen of this genera in comparision with *Quercus* or *Tilia.* However, *Betula* does not form forests in this area, it grows frequently on waste land, by streets and road-sides, being among the deciduos species the commonest tree.

Alnus always grows on river- and ditch sides and also form forests on all more wet and lower places. All the genera forming the mixed oak forests are encountered in pollen spectra not higher than one percent. The pollen of *Carpinus* and *Fagus* is still less frequent. *Carpinus* grows on the shores of our bay only as a insignificant admixture in mixed

forests. *Fagus* forests are here only in two places, namely at Rozewie, where the seashore turns westwards, and at Przebrno in the middle of spit of Vistula. (See the map, fig. 1). Alltogether the surface of this two beach forests is about 30 ha. This fact, and also the low pollen production of *Fagus* and its flowering not every year, accounts for the low percentage of this pollen (0,5—0,9%).

II. NAP (Pollen of shrubs and herbs)

No greater differences can be seen between the pollen percentages of the mentioned above pollen groups at subsequent depths of the bay. One exeption is in the group of spores i.e. the forest vegetation. Here we see a distinct concentration i.e. the increase of percentage of this group in the central part of the bay, from 20 to 100 m of depth, particularly along the line IV (Skowronki-Depth of Gdańsk).

I suppose, that this fact is a conequence of the action of the currents. As is presented on the map (fig. 1), the main shore currents by dominating western winds goes along the spit of Hel, toward south-east, and it is subsequently divided into two branches: one entering in the Bay of Puck, the second going along the shores of Bay of Gdańsk and along the Vistula spit, turning to the east. When the eastern winds prevail, the direction of the currents is reversed. (3). In both cases the direction of currents goes along the richest in forests shores of the bay: the both spits, Vistula and Hel. The spores of the forest vegetation (*Filices* and *Lycopodia*) collected by the currents are subsequently sedimented in the deep, central part of the bay, where the action of currents weakens with the depth.

Attention should be drawn to the cause of the AP dominance in the pollen spectra from the sea bottom surface, which does not at all correspond to the relation between the forests and the non woody vegetation on the shore area. The forests do not constitue 70—80% of the shore vegetation, like the polen spectra. In my opinion it is the consequence of the tree pollen being more easily transported by the winds to the sea, than the pollen of herbs and shrubs which can be stopped on its way to the sea by even small obstacles.

The secondary pollen is sometimes encountered on the surface of the bottom sediments of the Bay of Gdańsk, its amount being below 1%. This pollen comes from tertiary muds and brown-coal, whose layers are found in some cliff-shore places. K o r e n i e w a (1957) who made similar investigations on the Ochockie-sea states, that the secondary pollen differs from the primary by the colour and the degree of fossilisation. In the samples from the Bay of Gdańsk no such differences have been found and the secondary pollen can be distinguished only by

the determination of genera. The most frequent representatives of tertiary sporomorphs are the spores of *Lygodium* and the pollen of *Nyssa*.

It can be concluded that the pollen spectra from the surface of the bottom sediments of the bay are corresponding to the shore vegetation. It would be better to compare the spectra taken from several different areas of the sea. In the nearest future I will investigate to this purpose the surface samples from the Firth of Vistula and from the Firth of Szczecin.

SUMMARY

55 samples collected from the surface of bottom sediments in the Bay of Gdańsk were analysed palynologically. The samples were taken along five lines, running across the bay, as shows the map (fig. 1). The pollen spectra were counted total, 1000 grains in each sample. The counted pollen spectra were combined together in 5 groups, according to their situation in relation to the isobathes. An average pollen spectrum was calculated for each group of samples, the results are seen in the table nr. 1.

Nonarboreal pollen, found in low percentage, were determined as far as species, genus or family. The average NAP values were combined in some groups, marking the plant — communities which have produced this pollen (see table 1). The comparison of average pollen spectra from diverse depths shows in the sediments near the shore less pollen of Coniferae and more of deciduous trees than in deeper area. This phenomenon is caused by the structure of Coniferous pollen, which is better fitted for swimming and can be more easily transported to the depth.

Comparing the NAP spectra we observe the increase of percentage of forest spores (*Filices* and *Lycopodia*) in the central, deeper part of the bay. This concentration is a consequence of the action of currents (see the map), which collect the spores of forest vegetation along these shores of the bay, which are mostly covered with forests: the spits of Hel and of Vistula. The spores are subsequenly sedimented in the deep, central part of the bay, where the action of currents weakens. The pollen spectra of trees correspond aproximately to the vegetation of the shores of Bay of Gdańsk.

Oceanographic Institute
P. I. H. M. Gdynia

(Entered: 7.I.1961)

STRESZCZENIE

Zbadano metodą analizy pyłkowej 55 prób z powierzchni osadów dennych Zatoki Gdańskiej. Próby pobrano wzdłuż pięciu linii przecinających zatokę, jak to wskazano na mapce (rys. 1).

Spektra pyłkowe obliczano totalne, 1000 ziarn w próbce. Dla pięciu różnych głębokości zatoki obliczono średnie spektra pyłkowe, wyniki przedstawia tabela 1. Ziarna pyłkowe NAP oznaczano z dokładnością do rodziny, rodzaju lub gatunku, występowały one stale w niskich procentach. W tabeli 1 połączono sporomorfy niedrzewiastych w grupy, według przypuszczalnego środowiska, z którego pochodzą.

Porównanie średnich procentów pyłku drzew z różnych głębokości zatoki wykazuje, że w osadach przybrzeżnych jest nieco mniej pyłku drzew iglastych, a więcej liściastych, co jest spowodowane lepszym przystosowaniem pyłku iglastych do pływania, skutkiem czego jest on łatwiej przenoszony na głębię.

W grupie NAP zauważa się wzrost procentu zarodników paproci i widłaków w środkowej, głębszej części zatoki. Zagęszczenie to jest wynikiem działania prądów (patrz mapka 1), które zbierają pyłek roślinności leśnej wzdłuż najbardziej lesistych brzegów zatoki: mierzei Helskiej i Wiślanej. Zarodniki te osadzają się następnie w tej części zatoki, gdzie działanie prądów jest najsłabsze. Udział poszczególnych rodzajów drzew w spektrach pyłkowych osadów dennych odpowiada w przybliżeniu wegetacji wybrzeży Zatoki Gdańskiej.

Zakład Oceanografii
P.I.H.M. w Gdyni

REFERENCES

Erdtman G., 1943, An introduction to pollen analysis, Waltham Mass. U.S.A.
Koreniewa E. W., 1957, Sporowo-pylcewoj analiz donnych otłożenij Ochotskowo Moria, Trudy Inst. Okeanołogii 22.
Lauer Z., 1960, Warunki hydrologiczne strefy przybrzeżnej Zatoki Gdańskiej (rękopis).