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Łódź

RECOGNITION OF VALLEY EVOLUTION DURING THE PLEISTOCENE–HOLOCENE TRANSITION IN NON-GLACIATED REGIONS OF THE POLISH LOWLAND

Abstract

Opinions on evolution of valleys during the Pleistocene–Holocene transition (20,000–8,000 years BP) in non-glaciated regions of the Polish Lowland have been collected. A variety of types and dimentions of valleys as well as involved character of processes have been emphasized. In all valleys one should distinguish three main stages of development: 1. 20,000–14,500 years BP – the phase of braided river glacially and/or periglacially supplied, prevalance of aggradation. 2. 14,500–10,000 years BP – non-continuous erosion and transformation of braided pattern into the meandering one (large meanders). 3. 10,000–8,000 years BP – meandering pattern, transition from the large to the small meanders.

Despite the regional differences in both the progress and the methods of investigations, development in the field of evolution of extraglacial valleys has been regarded as advanced.

The work deals with the opinions on valley evolution during a span--time from the Upper Plenivistulian to the Early Holocene in these lowland Polish regions where the Middle Polish ice sheets were as the last ones, i.e. in the zone situated between the extent of the Odra Glaciation and the Vistulian Glaciation (Fig. 1). Due to the spatio-temporal neighbourhood as well as the magnitude of studies carried out in the Kotlina Płocka and in the middle Warta river valley, these areas have been also taken into account. Such spatial limits have been established in order to make the phenomena comparable. Undoubtedly, the author's scientific interest in the fragment of this region, namely the Łódź Plateau, which refers among other things to the question and the time-interval at issue (KUYDOWICZ--TURKOWSKA, 1975, TURKOWSKA, 1988, 1990, 1992a) has also prompted her to choose this terrain.

The valley system in the area in question is very well developed and varied. The valleys – from currently dry, denudational ones to broad valleys, also only partly utilized pradolinas – are considered to be here the most typical land forms, Their dimentions and location determined the manner of augmentation during the last glacial transgression, glacial or/and periglacial, and also presence or lack of other relationships with ice sheet (for example: blockage of flow). Just these features themselves conditioned a great variety of valley processes and point to the complexity

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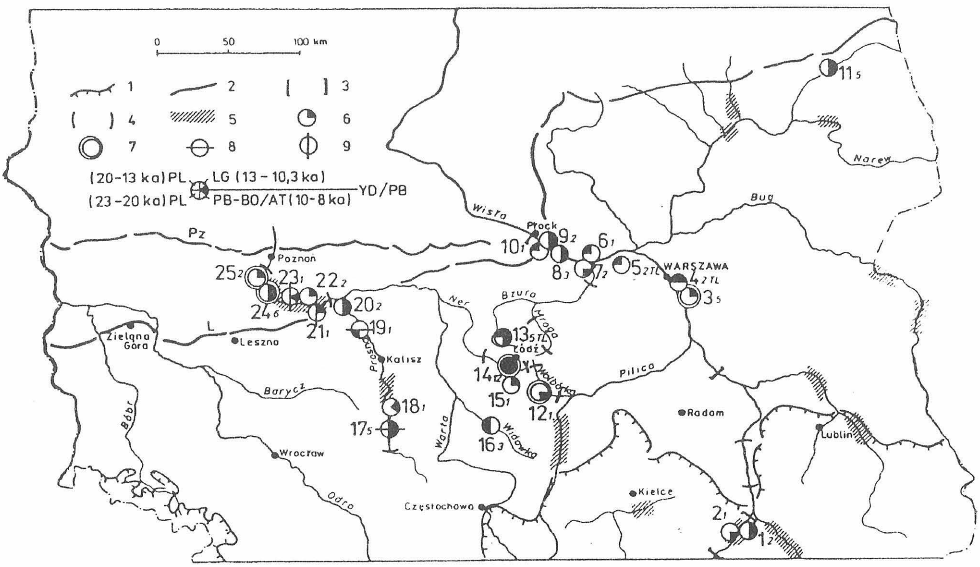

Fig. 1. Recognition of deposits and river valleys from the 20–8 ka BP period in Middle Poland (after Turkowska, 1992a)

1. extent of the Odra Glaciation; 2. extent of the Vistula Glaciation (L – the Leszno Phase, Pz – the Poznań Phase); 3. fragments of the Vistula river valley narrowly examined within the framework of the IGCP 158A Programme; 4. other fragments of valleys well recognized geologically and morphologically; 5. fragments of valleys with pattern identified through detailed topographic maps and air photographs; 6. sites dated by 14C (or TL) method. The site number as listed below, the amount of dated samples and approximate results: PL – Plenivistulian, LG – Late Vistulian, PB – Preboreal, BO – Boreal, AT – Atlantic, YD/PD – Younger Dryas/Preboreal turn; 7. sites dated palynologically; 8. detailed palynological works; 9. estimation of palaeodischarge. Sites: 1. Kobylarnia, 2. Tarnobrzeg, 3. Całowanie, 4. Wiązownia-Piekiełko, 5. Granica, 6. Kamion, 7. Nowa Wieś and Wola Ładowska, 8. Bończa, Juliszewo, Słupna, 9. Liszyno, 10. Budki Ciechomickie, 11. Wizna, 12. Świątniki, 13. Rudunki, 14. Lublinek, 15. Bychlew, 16. Bełchatów, 17. Wieruszów, 18. Brzeziny, 19. Macew, 20. Żerków, 21. Gogolewko, 22. Mechlin, 23. Czmoń, 24. Jaszkowo, 25. Żabinko

of problem. Summarizing the works compiled so far, one could say that all main types of the valley forms active during the Pleistocene–Holocene transition have been subjected to detailed investigations, however study areas were very irregularily distributed in the Polish Lowland (Fig. 1). They were situated in three regions. The middle Vistula river valley is the first one, especially narrowly investigated within the framework of the IGCP 158A Programme (Andrzejewski, 1991; Baraniecka, Konecka-Betley, 1987; Florek, E., Florek, W., Mycielska-Dowgiałło, 1987; Sarnacka, 1987; Starkel, 1983a, 1990; Wiśniewski, 1987). Formation of this valley was controlled by flow from upper, mountain parts of catchement and also by direct influence of the Scandinavian ice sheet. Methodologically, the investigations into the Prosna river and Warta river valleys are most advanced. The Prosna valley was situated within periglacial zone but it's base level was in relation to changing extent of the Vistulian ice sheet (Rotnicki, 1988; Rotnicki, Borówka, 1990; Rotnicki, Latałowa, 1986;

ROTNICKI, MŁYNARCZYK, 1988). The Warta valley was located within the Leszno Phase, therefore it was the pradolina during the Poznań Phase and afterwards, i.e. from the Pomeranian Phase, the river valley (ANTCZAK, 1985; GONERA, KOZARSKI, 1987; KOZARSKI, 1983a, b; KOZARSKI, GONERA, ANTCZAK, 1988; KOZARSKI, ROTNICKI, 1978; WITT, 1975). The watershed area of the Łódź Plateau, the third region of investigations, gave an opportunity, on the one hand, to study the upper sections of streams only, but at the same time, to work out the valleys in which glacial influence did not merge with the periglacial one (KUYDOWICZ-TURKOWSKA, 1975; TURKOWSKA, 1988, 1990, 1994). Studies conducted in dry valleys are equally important for recognition of the entire valley system because, among other things, their fillings have been observed to the full, which is hardly ever possible in larger forms (KLATKOWA, 1965, 1989).

Prior to the maximum extent of Vistulian ice sheet, the river valleys of non-glaciated area were subjected to erosion. This process in the Prosna valley, where it has been originally described, is dated between 23,000 – – 24,000 and 18,000 – 20,000 years BP and is considered to be of the first rank among all erosional phases. Due to these facts ROTNICKI (1988) suggests to call it "the Prosna Phase". He connects this erosion with the humidification reflected in the Scandinavian ice sheet transgression. Rotnicki stresses that such episode has not been recognized in other valleys. This statement seems to be not accurate. The examples provided from the upper sections of streams of the Łódź Plateau show bipartition of the Plenivistulian high terrace deposits resulting from this erosion. The "Paudorf" erosional surface was determined as an outstanding feature of the Mroga river valley filling many years ago (KUYDOWICZ-TURKOWSKA, 1975) and then supported in the other valleys (TURKOWSKA, 1988, 1994). Geological records in the upper Ner river valley have located the erosion phase later than 21,720 ± 200 years BP, whereas in the nearby fossil form earlier than 17,100 ± 200 years BP. This process generated here the fresh valley, cut in the Warta till (TURKOWSKA, 1992b). Dates 22,200 ± 200 years BP (MANIKOWSKA, 1994) and 21,970 ± 810 years BP (BARANIECKA, 1982) confirm the similar age of this phase in the Widawka drainage basin. All datings mentioned above have been derived from pleniglacial overbank deposits (perhaps associated with anastomosing pattern) that built the core of high terrace in valleys of the Łódź Plateau or the highest (II) Vistulian terrace in the Prosna valley. TL dates from sandy-silty filling of the dry valley in Rudunki, synchronic with terrace deposits, also set the unconformity surface at slightly earlier than 20,000 years BP (Fig. 2, Tab. I) (KLATKOWA, 1989).

Thus, this erosional horizon marks the bottom boundary of interests in determined time-interval. The first stage of valley evolution in that time within the non-glaciated lowland area reached the Epe phase (*vide*

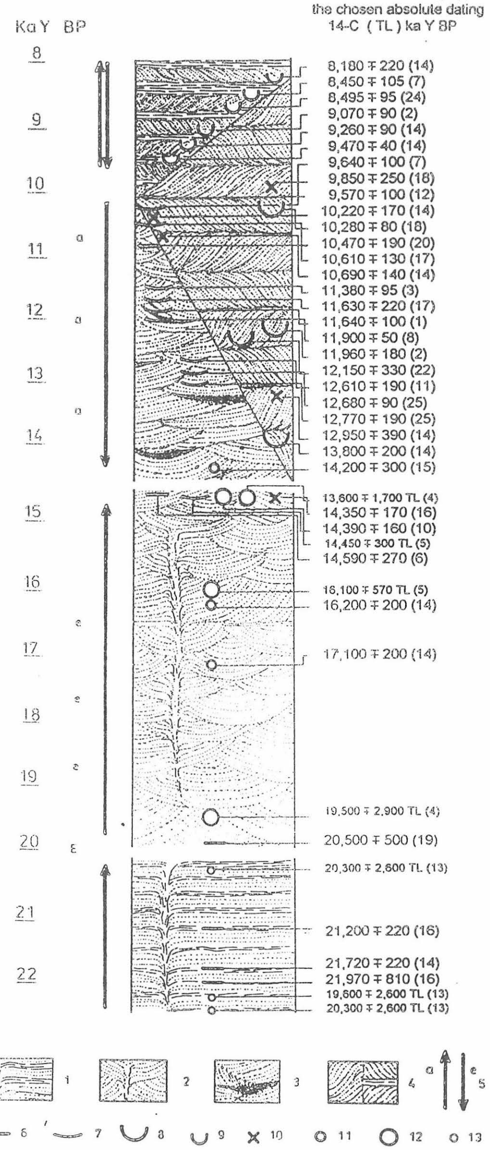

Fig. 2. Evolution of valleys and properties of the valley deposits from the period 20,000–8,000 in Middle Poland

Main series of deposits: 1. medium– and fine-grained sand interlayered with silt, overbank (periglacial shallow water basins, anastomosing pattern (?), prevalance of vertical accretion, syngenetic ice-wedge casts; 2. various -grained sand with admixture of gravel in places, braided pattern, periodically and in some places over ice, high energy, syngenetic and epigenetic structures; 3. braided pattern, prevalance of channel deposits, abandoned channels filled with organic material; 4a. various-facies deposits of meandering river, large meanders; 4b. various-facies deposits of meandering river, small meanders. Tendencies in valley floor evolution; 5a. prevalance of aggradation; 5b. prevalance of erosion; E – main phases of erosion; e – local (and of the minor rank) dissecting of valley floors; a – local aggradation. Absolute 14C datings (in the margin of figure – date and number of the site as in Fig. 1): 6. inserts of organic material in the Middle-Plenivistulian deposits of shallow water basins; 7. braided channels; 8. large meanders; 9. small meanders; 10. organic detritus; 11. datings from tributary fossil valleys; 12. TL datings in the Wistula river valley; 13. TL datings in the dry valley at the Rudunki site

KOZARSKI, 1991) and, in majority of cases, resulted in the highest Vistulian terrace. Valleys directly affected by ice sheet recession are the exceptions. An example of such circumstances has been provided by ROTNICKI (1988) from the Prosna valley, where four terraces (III, IV, V, VI) correspond to the Leszno Phase, the Poznań Phase, the Pomeranian Phase and the Gniezno Oscillation respectively. During the Upper Plenivistulian stage all valleys were characterized by braided pattern, which, in relation to the climatic conditions has been originally stressed by FALKOWSKI (1969, 1975, 1980). A cessation of the infiltration process, controlled by the frozen ground, caused surface runoff to be increased as well as the flood events to be more rapid. In some valleys, such as the Mroga, the naled has been documented (KUYDOWICZ-TURKOWSKA, 1975). Valley floors were fashioned with a significant involvement of the transverse transport: slope deposit (chiefly in small, incised forms) and proluvial material. Supply of sediment was accelerated by thermal erosion. Existence of braided pattern has been inferred from measurements showing a poor variety of layer dips in deposit, from the study of transverse profiles through fossil channels (broad, shallow, symmetrical) as well as their arrangement at the surface, which is readily identified on detailed topographic maps and air photographs (Fig.1; SZUMAŃSKI, 1982, 1983). It seems to be necessary to emphasize once again that in vast majority of cases the rivers tended to aggrade (Fig. 2). This process produced multicyclic sandy covers that consist exclusively of channel deposits, without any organic admixture. They were incorporated in permafrost, which is evidenced by syngenetic ice-wedge casts reported from many valleys (GOŹDZIK, 1994). Deposits of periglacial waters, as opposed to the synchronic glacial covers, are strongly eolized (GOŹDZIK, WACHECKA, 1992; ROTNICKI, 1986). The RM and γ classes reach often over 50% of grains of 0,5–0,8 mm fraction, thus the same amount as in overlying aeolian blankets occurs (GOŹDZIK, 1994; MANIKOWSKA, 1992). Such feature is regarded, among other things, as the proof of short-lived operation of running water whereas extremally poor sorting of sediment indicates a rapid decrease in maximum floods.

During the Vistulian Glaciation river and glacial waters built the highest terrace of the middle Vistula valley, known in the literature as the Otwock, dune terrace (BARANIECKA, KONECKA-BETLEY, 1987; SARNACKA, 1987) or as the TP–1 terrace (FLOREK, E., FLOREK, W., MYCIELSKA-DOWGIAŁŁO, 1987; MYCIELSKA-DOWGIAŁŁO, 1987). In the Warsaw Basin, at the Wiązownia-Piekiełko and Granica sites the terrace deposit was dated by the TL method (Fig. 1, 2; Tab. I). It was the sole available method of absolute age determination because of the above mentioned lack of any organic remains. An absence of organic matter was probably a response to severe climatic conditions and also intense periodic runoff. Only the top of terrace contains soil horizons and organic fills of the abandoned braided

Absolute datings of river deposits in the non-glaciated area of the Polish Lowland from the Pleistocene–Holocene transition

Table I

Valley	Number	Site	Age ka BP, ^{14}C, (TL)	Deposit and sampled locality	Cited work
Vistula	1.	Kobylarnia	11,640±100	peat, the bottom of braided channel filling (fan of the second generation dissected in the Allerød)	MYCIELSKA-DOWGIAŁŁO (1987)
	2.	Tarnobrzeg	9,070±90	organic alluvia, the bottom of filling of palaeomeander of the second generation	
	3.	Całowanie	11,380±95	organic layer at the bottom of sand bed, depth 3 m	BARANIECKA, KONECKA-BETLEY (1987)
			11,190±65	peat layer at the top of Praga terrace, depth 2 m, dunes and peatbog above	
	4.	Wiązownia-Piekiełko	19,500±2,900 (TL) 13,600±1,700	sand and very fine sand, the top of Otwock (dune) terrace, synchronic fluvioglacial and fluvial accumulation	
	5.	Granica	16,100±570	silt, the top of high terrace	
			14,450±300	sand, the top of high terrace	
	6.	Kamion	14,590±270	fossil soil at the top of dune terrace, at the base of dune	MANIKOWSKA (1992)

	7.	Nowa Wieś Wola Ładowska	9,640±100 8,450±105	gyttia, abandoned channel, TP–2 gyttia, abandoned channel, TP–2	FLOREK E., FLOREK W., MYCIELSKA-DOWGIAŁŁO (1987)
	8.	Bończa	11,900±500	gyttia, abandoned channel, TP–1	
		Juliszewo	10,500±270	gyttia, abandoned channel, TP–2	
		Słupna	9,620±300	gyttia, abandoned channel, TP–2	
	9.	Liszyno	10,400±180	soil horizon at the base of dune, TP–2	
	10.	Budki Ciechomickie	14,390±160	peat, abandoned channel of braided river	
Biebrza	11.	Wizna (peatbog)	12,610±190	cyperaceos-moss peat at the bottom of peatbog (40 cm silty gyttia under it), at pradolina terrace	ŻUREK (1991)
Wolbórka	12.	Świątniki	9,570±100	peat, the bottom of peatbog, valley floor, aggradation in the Eo- and Neoholocene	TURKOWSKA (1988)
dry	13.	Rudunki	12,800±1,900 (TL)	filling of dry valley, thinly laminated sand	KLATKOWA (1989)
			17,500±2,600 (TL)	filling of dry valley, sandy-silty series	
			19,600±2,900 (TL)		
			20,300±3,000 (TL)		

Ner	14.	Lublinek I	8,180±220	organic alluvia, the bottom of filling of small meandering channel	Turkowska (1988, 1990)
			8,240±160	the cone in point bar	
			8,350±160	organic alluvia, the bottom of channel filling	
			8,400±200	peat, the top of channel filling	
			9,380±250	organic detritus, point bars	
			9,200±70	the oak trunk, 80 cm in diameter	
			9,800±190	the pine trunk, 30 cm in diameter	
			9,850±250	block of organic alluvia	
			12,950±390	block of organic alluvia	
			13,800±200	organic alluvia, the bottom of fossil channel filling with large parameters, 8 m below the top of Plenivistulian terrace	
			21,720±220	sandy silt, slightly organic, overbank deposit	
		Lublinek II	8,250±150	the branch, fan of tributary valley, the top part	Turkowska (1992b)
			11,320±180	organic alluvia, filling of fossil valley, the top of lower silty-sandy series	
			12,470±180	soil horizons in sandy-silty filling of fossil valley	

			16,200±200		
			17,100±200		
Pabianka	15.	Bychlew (Dąbrowa)	14,200±400	lens of peat in silt, filling of dry valley	KLATKOWA (1989)
Widawka	16.	Bełchatów	14,350±170	the cone, the top of Plenivistulian terrace	GOŹDZIK (1990) MANIKOWSKA (1990) BARANIECKA (1982)
			21,200±220	organic alluvia, overbank deposit	
			21,970±810	organic alluvia, overbank deposit	
Prosna	17.	Wieruszów (Mirków)	9,380±210		ROTNICKI (1988)
			9,770±250	peat, filling of palaeochannel	
			10,610±130		
			11,630±220		
	18.	Brzeziny	10,280±80	the bottom of filling of large palaeomeander of the first generation	ROTNICKI, LATAŁOWA (1986)
	19.	Macew	20,500±500	layer of organic silt below the top of III terrace of the Leszno Phase	ROTNICKI, BORÓWKA (1990)
	20.	Żerków	10,470±190	the bottom of peat, in aeolian sand covering the lowest terrace	ROTNICKI (1988)

Warta	21.	Gogolewko	11,960±180	the bottom of large meander filling	KOZARSKI, GONERA
	22.	Mechlin	11,500±100	the bottom of large meander filling	ANTCZAK, (1988)
	23.	Czmoń	10,250±190	filling of palaeomeander, reduced parameters	
			10,850±180		
	24.	Jaszkowo	8,495±95	peat	KOZARSKI, ROTNICKI (1997)
			9,650±240	detritus gyttia	
			9,770±230	organic-calcareous alluvia	
			9,780±340	organic detritus	
			11,450±630	calcareous gyttia	
	25.	Żabinko	12,680±90	filling of braided channel at the top of bifurcation	KOZARSKI, GONERA, ANTCZAK (1988)
			12,770±190	terrace, at the base of dune	

Comment: only the most important dates (mainly from the bottom of palaeochannels) from sites marked in Fig. 1 have been cited. Selected references were often published after the site had been recognized channel. These organic beds are taken to be the indication of the beginning of channel cutting. The date estimated for the soil horizon underlying the dune in Kamion near Wyszogród – 14,570 ± 270 years BP (MANIKOWSKA, 1992) and the similar one for the bottom of 3 m deep abandoned channel at Budki Ciechomickie site – 14,390 ± 160 years BP (FLOREK, E., FLOREK, W., MYCIELSKA-DOWGIAŁŁO, 1987) point to recession of the Pomeranian ice sheet so the "Epe phase" as the period in which channel runoff was ceased. The Dunish name of this stratigraphic unit is proposed by MANIKOWSKA (1992) to be replaced by the Polish expression "the Kamion phase" from the first recognized in our country site of this period.

In the Warta valley, from the Poznań Phase until the Oldest Dryas, the bifurcation terrace was active – III according to BARTKOWSKI – (KOZARSKI, ROTNICKI, 1978; WITT, 1975). At the base of inland dune in Żabinko, 14 m in height, NOWACZYK documented in 1981 braided deposits. The top of this sequence, namely the bottom of palaeochannel filling, has been dated back to the Bølling (12,770 ± 190 and 12,680 ± 90 years BP; *vide* KOZARSKI, GONERA, ANTCZAK, 1988). The Oldest Dryas–Bølling boundary is considered to be a transition from a poor shrub tundra to a park tundra. The change in vegetation cover is regarded by KOZARSKI (1983 a, b) as an important control of tendencies in valley floor development. A comparision of data from the Vistula valley with records from the Warta valley implies the local conditions to be responsible for a change in the river behaviour from aggradational to erosional, i.e. either it preceded the Oldest Dryas, thus simultanously with apperance of poor plants in the arctic desert, or it followed this period, when the park tundra dominated. There is no denying that the interrelation between the valley's location and the retreating ice sheet, therefore the direct influence of changing base level, was the relevant or even crucial factor. As evidenced in the Prosna valley this factor could cause deepening of the valley floor, which repeated many times during the Upper Plenivistulian stage (ROTNICKI, 1988).

During this period in the periglacial valleys of the Łódź Plateau aggradation predominated. The poligenetic (slope, proluvial, fluvial processes), various-grained (the majority of sand), locally varied, 1,5–3,0 m thick series built the top of high terrace, thus rest over the above mentioned erosional unconformity surface from before 20,000 years BP (Fig. 2; KUYDOWICZ-TURKOWSKA, 1975; TURKOWSKA, 1988, 1992a). There now exists the only absolute date for this deposit but it's interpretative value is limited. ^{14}C analysis of the cone from the top of Plenivistulian terrace in Bełchatów gave a result 14,350 ± 170 years (GOŹDZIK, 1994) – therefore accumulation must have been finished later than about 14,500 years BP.

Deposits of the top of high terrace correspond to the "upper" stone pavement of dry valleys (KLATKOWA, 1965).

During the Late Vistulian the river valleys of the Polish Lowland were deepened, however it was the multiphase process, interrupted with aggradation. For instance, following stages were involved in the Vistula valley evolution (BARANIECKA, KONECKA-BETLEY, 1987): dissection of the Otwock (dune) terrace, from the Agard phase until the Bølling; formation of the Falenica terrace; erosion ascribed to the Older Dryas; accumulation of the Praga terrace deposits (this terrace was abandoned in the Allerød); formation of the Nowy Dwór terrace. Erosion processes have been inferred from the dating of fillings of abandoned channels and soil horizons. Dried area, favourable to aeolian sedimentation, was soon setteled by the man, as at the Całowanie site was. A great deal of data enabled the researchers to study this site narrowly (*vide* BARANIECKA, KONECKA-BETLEY, 1987; SARNACKA, 1987). Based on the results from the Vistula river valley between Kępa Polska and Płock as well as their comparision with the Tarnobrzeg course and the Całowanie site MYCIELSKA-DOWGIAŁŁO states that strong downcutting proceeded in this form in the time-interval 11,900 ± 500–10,500 ± 270 and resulted in the high scarp separating the TP–1 terrace from the TP–2 terrace (FLOREK, E., FLOREK, W., MYCIELSKA-DOWGIAŁŁO, 1987). Nevertheless, the already mentioned phase of erosion older than 13,000 years BP is considered to be the main one during the Late Vistulian. In southern Poland it has been also recognized, although in the upper Vistula drainage basin is evidenced only geologically, in the shape of silty fillings of palaeochannels from this period situated below present-day alluvial plains. Even there this erosion is interpreted as cutting back due to deglaciation and falling base level (STARKEL, GĘBICA, 1992).

In the Biebrza and Narew pradolina the dissection of terrace up to the floodplain "no later than 13,000 years ago" commenced the postglacial stage of development. This was manifested, first of all, in formation of isolated peatbogs. Just age of the bottom peaty layer, underlying with 40 cm thick silty gyttia, at the Wizna site – 12,610 ± 190 years BP locates the dissection older than the Bølling (ŻUREK, 1991).

The Plenivistulian terrace of the upper Ner river valley had been dissected before 14,000 years BP to a depth of 8 m, i.e. to the lowest recorded level of the Latevistulian valley floor. Age of the bottom of palaeochannel organic silt filling has been established at 13,800 ± 200 years BP. The palynological expertise made by BALWIERZ is "not at odds with this date". Presumably it is the oldest meandering channel among dated so far. Unfortunately, destruction of the upper part of filling due to the Holocene processes as well as the younger bed, partly secondarily deposited, make the reconstruction of channel geometry impossible and decrease the reliability of such statement. However, the author would like to remind that both the former structural–textural analysis of the Latevistulian deposits exposed at excavations at the purification plant in Łódź and morphological features of the upper Ner valley allowed to accept the hypothesis on the change in channel pattern from braided into meandering immediately after the Pomeranian Phase (TURKOWSKA, 1990). In other valleys of the Łódź Plateau this transformation took place later, e.g. in the Mroga valley on the turn of Vistulian. Thus, assuming the same geological and climatic conditions, drainage pattern was controlled by the local topography, that is flatness of valley favoured fast changes whereas diversity, stimulating the slope processes, delayed them (TURKOWSKA, 1988, 1990).

The question of change in channel pattern still remains one of the main thread running through the fluvial investigations (FALKOWSKI, 1969, 1975, 1980; KOZARSKI, ROTNICKI, 1978). Results attained from the Łódź Plateau leave no doubt that apart from the climat, the local factor played here an important role. Therefore the discrepancies in dates and the divergence in opinions on the beginning of meandering are apparent. The most extreme examples have been provided from the upper Ner valley where meandering pattern occurred before 14,000 years BP and from the lower Prosna river near Kakawa where the braided pattern has endured up to day (ROTNICKI, STARKEL, 1991). S. KOZARSKI since the middle of the 1970s has maintained the thesis on large meanders at the so-called transitional terrace level in the middle Warta valley from the Bølling. Palaeochannels of this stage of flow was filling up from the Older Dryas. This has been evidenced by the palynological analyses as well as the ^{14}C datings: at the Jaszków site – 11,430 ± 630 years BP, at the Mechlin site – 11,500 ± 100 years BP, at the Gogolewko site – 11,960 ± 180 years BP. The channels that were active during the Allerød, e.g. in Czmoń, were incised deeper, had slightly smaller parameters and the bottom of their fillings originated in the Younger Dryas (Tab. I; KOZARSKI, GONERA, ANTCZAK, 1988). It ought to be reminded that MYCIELSKA-DOWGIAŁŁO in the Vistula valley and SZUMAŃSKI in the lower San valley dated the beginning of meandering exactly to the Allerød whereas FALKOWSKI in the Vistula drainage basin and ROTNICKI in the Prosna river only to the Preboreal. However, further investigations of the large palaeomeander in Brzeziny near Wieruszów gave evidence of the Prosna river meandering as early as the Younger Dryas (ROTNICKI, LATAŁOWA, 1986).

Methodical and model approach to fluvial processes at the Quaternary Research Institute in Poznań in the 1980s inaugurated a new stage of investigations. Application of modern methods has offered an opportunity of achieving more and more detailed quantitative characteristics of deposits, palaeohydrology and development of the Prosna and Warta rivers during the Late Vistulian and the Holocene. In the Prosna river valley following tasks have been undertaken: estimation of parameters of palaeochannels and palaeovelocities (ROTNICKI, 1983), reconstruction of discharge inferred from the analysis of mineral fillings of palaeochannels (ROTNICKI, Młynarczyk, 1988), reconstruction of climatic changes as well as plant development in the light of analyses of organic deposits (e.g. Rotnicki, Latałowa, 1986). These problems have been also studied in the Warta valley (Kozarski, 1983a, b; Kozarski, Gonera, Antczak, 1988; Gonera, Kozarski, 1987). Compared with the present-day values, discharge in large Late-vistulian meanders of the Warta and Prosna rivers was five times bigger. Mean annual discharge during the Younger Dryas in the Prosna river was 23,6 m^3s^{-1}. K. Rotnicki states that it was connected with irregular precipitation which, in turn, was caused by noticeably lower mean annual temperature. The cutoff channel in Brzeziny was quickly filled up, 2,8 mm per year on average, chiefly with mineral deposit. The Younger Dryas decline coincided with the end of high stages of water, absence of sandy inserts in the upper parts of buried channel proves this (Rotnicki, Latałowa, 1986).

The participants of the IGCP Symposium "Evolution of natural environment in Poland during the Pleistocene–Holocene transition, 20,000–8,000 years BP", held in Łódź in October 1992, postulated a paying attention to the role of cooling during the Younger Dryas. In the light of works compiled so far, the river's response to severer climatic conditions and a return of the park tundra is obvious in many valleys. Apart from the results of latest, cited above, investigations carried out within the Prosna and Warta valleys, e.g. analysis of the palaeochannel in Czmoń (Kozarski, Gonera, Antczak, 1988), examples of similar behaviour were provided earlier: from the water gap section of the Warta river valley (Krzemiński, 1965) or from the Mroga river valley (Kuydowicz-Turkowska, 1975) where aggradation during this period resulted in deposition of lower terrace material. According to Falkowski's (1975) scheme, braided pattern reappeared in the Polish Lowland valleys in the Younger Dryas. A rapid change in sedimentation has been recorded in the valleys of the Carpathian rivers on the turn of Allerød, organic deposits were covered by overbank deposits and silt transited into sand. The thinness of vegetation cover caused the debris to be active, aggradation of valley floors simultanously with lateral erosion was the typical feature (Starkel, Gębica, 1992).

Thus, it ought to be stressed that despite the general tendency to erosion during the Late Vistulian, in the upper sections of valleys aggradation could occur. In dry valleys of the Łódź Plateau similar situation has been observed, namely the so-called thinly laminated, upper sand overlies the Upper Plenivistulian stone pavement (Klatkowa, 1965, 1989).

It is known that the boundary between the Late Vistulian and Holocene is marked in pollen diagrams by a rapid drop in herbaceous pollen grains (NAP) and an increase of birch and pine pollen grains which prove the development of compact forest. Thus an increase of temperature and decrease in precipitation were simultaneous with less runoff and an absence of high-water which, in the fillings of palaeochannels, is manifested by the decay of sandy sets and the occurrence of dense organic fillings. For instance, in the above mentioned oxbow lake of the Prosna river in Brzeziny, during the Preboreal and the Boreal the peat was accumulated. During the Boreal it was the wood peat which points to the forest advance. The accretion rate (0,9–0,6 mm per year) was three–four times slower than in the Younger Dryas and about 8,500 years BP the process was completed (ROTNICKI, LATAŁOWA, 1986). Threshold conditions generated the new cutoffs, e.g. in the Vistula valley where the bottom of their fillings has been dated back to the Preboreal (MYCIELSKA-DOWGIAŁŁO, 1987; FLOREK, E., FLOREK, W., MYCIELSKA-DOWGIAŁŁO, 1987; Fig. 2). The forest cover, hence regular drainage pattern during the Early Holocene were responsible for a reduction in geometric parameters of meanders and a narrowing of the meandering belt. Such tendencies are the chief features of valley floor development in this time. Apart from the analyses based on air photographs which gave an opportunity of describing the horizontal parameters only (FALKOWSKI, 1975; SZUMAŃSKI, 1982, 1983), the methods useful for establishing a depth and slope of channels as well as for estimating the palaeovelocities are worth noticing (ROTNICKI, 1983). River channel adjustment to the altered conditions of flow at the beginning of Holocene caused the average channel width to decrease by about quarter (in the middle Warta from 58,9 m up to 45,0 m), the average depth by almost half (from 3,64 m up to 2,17 m), the average radious of curvature similarly (from 247,1 m up to 140,6 m; KOZARSKI, 1983b). In the valleys characterized by aggradation during the Holocene the just outlined tendencies are maintained in the shape of fossil forms. For example, small channels of the upper Ner valley with organic deposits dated at 8,400 ± 150, 8,350 ± 160, 8,170 ± 220 years BP, which cut up point bar deposits of the large Latevistulian meanders, rest about 4,5 m below the present-day valley floor.

The review of investigations of the valley development during the Pleistocene–Holocene transition within the non-glaciated part of the Polish Lowland presented in this article allows to assume that the recognition of this problem is satisfactory. Wide range of interest reflecting a complexity of discussed phenomena, namely the dimentions of forms, their relation to ice sheet and various local conditions seems to be especially profitable. On the other hand, a lot of people involved thus different approach as well as advancement of investigations make the comparison of results difficult or impossible sometimes. Effort to standarize the methods (being undertaken within the framework of national or international Projects) and to complete the descriptive characteristics with the quantitative and model ones should be the main tasks in the near future. The appraisal of particular factor magnitude in valley development and the most precise possible criteria for distinguishing between the general, chiefly climatically controlled, and local tendencies require greater attention as well. We are becoming more and more conscious of the necessity to consider the fossil, similarly as the present-day, fluvial processes against the background of other environmental factors and their interrelationships (RALSKA-JASIEWICZOWA, STARKEL, 1988). Such ecological approach to paleogeographical interpretations of the Pleistocene–Holocene processes was strongly emphasized during the Symposium in Łódź in October 1992. Evaluating the role of individual time-intervals in formation of present-day environment and appraising the results obtained so far the participants came to a conclusion that especial attention should be focussed on the study of the Younger Dryas phase.

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