Biuletyn Peryglacjalny, no. 38, 1999

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SOME REFLECTIONS ON THE ŁÓDŹ CONTRIBUTION TO PERIGLACIAL RESEARCH AND EVALUATION CRITERIA OF PERIGLACIAL MORPHOGENY IN MIDDLE POLAND

Abstract

General history of Łódź periglacial research, particularly in the time when JAN DYLIK coordinated works of Periglacial Geomorphology Commission of IGU (1956–1972) are presented. Criteria used in the assessment of the periglacial environments of middle Poland are discussed. It is stressed that periglacial covers, which are often regarded as the one criterion of the evaluation of effects of periglacial morphogeny, are not complete evidence. Examples of indicators of periglacial conditions in glacial interfluve areas (pavements, wind-worn stones, periglacial structures) as criteria of periglacial morphogeny are reminded. The positive balance of erosion under periglacial conditions (denudational slopes, erosional valleys, deflation) causes difficullities in the quantitative assessment. According to the author, the theory of JAN DYLIK about the periglacial nature of middle Poland relief is still up-to-date.

REMARKS ON ŁÓDŹ PERIGLACIAL RESEARCH

Periglacial investigations in Łódź started at nearly the same time as the Łódź University and Geography Department were founded (1945). The concept of periglacial morphogeny was put forward before glacial features of the Łódź Plateau were precisely examined. Generally speaking, the thesis about omnipresent denudation was a response to impossibility to adopt a scheme for the areas of last glaciations to the morphological features of middle Poland.

The term *periglacial* and the concept of periglacial zone in Europe during the Pleistocene were introduced as early as 1909 by WALERY ŁOZIŃSKI, the Polish geologist, geographer and pedologist. It was the article entitled "WALERY ŁOZIŃSKI's merits for the advancement of periglacial studies" by ALFRED JAHN (1954) that commenced the first issue of *Biuletyn Peryglacjalny*. According to A. JAHN the rise of periglacial interest, both in Poland and other countries, coincided with the geological congress in Stokholm in 1910 and an accompanied trip to Spitsbergen and concerned mostly contemporary phenomena (formation of patterned ground,

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blockfields, solifluction). Afterwards, just before World War II, the interest was focussed on Pleistocene periglacial problems.

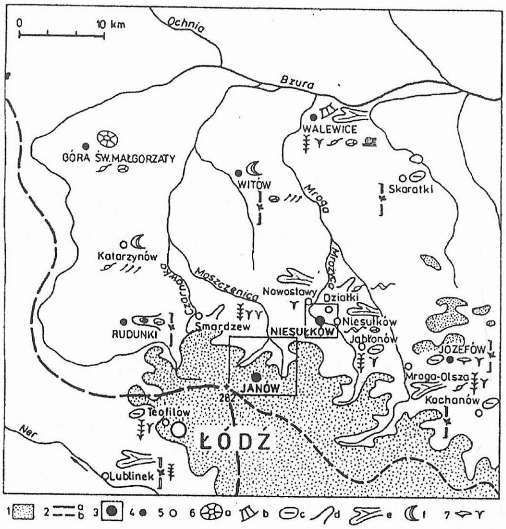

Fig. 1. Selected localities of periglacial research in the edge zone of the Łódź Plateau

1. area above 200 m a.s.l.; 2. watershead: a – Wisła–Odra, b – Bzura–Pilica; 3. sites presented during the symposium 1999; 4. the most important localities investigated by DYLIK (Józefów, Góra św. Małgorzaty, Walewice), DYLIKOWA (Witów) and KLATKOWA (Rudunki); 5. other localities; 6. morphological features: a – residual hills, b – slopes, c – close depressions, d – dry valleys, f – dunes; 7. permafrost evidence and indicators – symbols after H. KLATKOWA (1996), fig.2

When geological and geomorphological mapping of the Łódź area revealed some properties of superficial deposits and landforms which seemed unaccountable in the light of glacial and normal morphogenetic cycles, JAN DYLIK made an attempt to explain the provenance of these structures, deposits and forms after WALERY ŁOZIŃSKI concept, and formulated the hypothesis about the presence of periglacial environment in belts of terrain marginal to the succesive Scandinavian ice sheets. Most of the principles of the concept of periglacial morphogeny were worked out from studies carried out in the northern part of the Łódź Plateau (Fig. 1) and afterwards verified elsewhere – in the Holy Cross Mts., Lublin Upland, Carpathian Forefield and Sudety Mts. Inferences were drawn from field evidence, by direct rigorous observation of forms and determination of their origin from deposits and interpretation of processes. First periglacial studies on structures and loess-like deposits were published by JAN DYLIK in 1951. In 1952 he presented his view on the role of periglacial morphogeny in relief formation in: "The concept of the periglacial cycle in Middle Poland" (in *Bulletin de la Sociéte des Sciences et des Lettres*, Łódź, 3) and in 1953 in two papers: „O peryglacjalnym charakterze rzeźby środkowej Polski" (in *Acta Geographica Lodziensia*, 4, in Polish, with

Examples of Jan Dylik participation in international geographical and periglacial life

Table I

Year	Place	Conferences	Titles of papers	Remarks
1956	Rio de Janeiro	VIII IGU Congress	Esquisse des problèmes périglaciaires en Pologne	appointment of Dylik as chairman of IGU Commission on Periglacial Geomorphology
1957	Svalbard			investigations of actual periglacial phenomena
1957	Moscou	Periglacial Conference		the only representative of Poland
1957	Madrid Barcelone	Vth INQUA Congress	The zonal differenciation of the glacial relief in Poland; The morphological and stratigraphical role of fossil soil	
1958	Łódź	I Periglacial Conference	Rhythmically stratified slope vaste deposits	chief of organizing committee
1959	Liège	Colloque sur le périglaciaire pré-würmien	Sur le système triparti de la stratigraphie du Pléistocène	organized by P. MACAR
1959	Rabat	II Periglacial Conference	Analyse sedimentologique des formations de versant remplissant les depressions aux environs de Łódź	co-organization with R. RAYNAL
1960	Stockholm	XIX IGU Congress	Progress of the Periglacial Geomorphology Commission works	with R. RAYNAL appointment of J. DYLIK for the second time
1960	Abisko	Symposium of glacial and periglacial geomorphology	Présentation des cartes mondiales du périglaciaire	
1961	Warsaw	VIth INQUA Congress	Sur les changements climatiques pendant la dernière période froide	member of the organizing committee, editor-in-chief of the guide-books
1964	London	XX IGU Congress	Dépôts de versant à litage périodique; Tendences nouvelles dans les recherches périglaciaires	appointment of J. DYLIK the third time; with R. RAYNAL
1964	Austria, Hungary	III Periglacial Conference	Rhythmically bedded slope deposits	co-organizer of conference
1965	Fairbanks, Alaska	Periglacial Symposium		member of Polish team
1966	Liège, Louvain	IGU joint Symposium		member of Polish team
1967	Wrocław, Łódź Kraków, Toruń	IGU joint Symposium	Slope development under periglacial conditions	chief of the organizing committee, Periglacial Commission and Commission of evolution of slopes
1968	Wrocław	Loess Symposium	L'action du vent pendant de dernier l'âge froid dans la Pologne Centrale	
1968	Delhi	XXI IGU Congress	The significance of the slope on geomorphology	appointment of J. DYLIK for the fourth time
1969	Yakutsk	IGU joint Symposium	The earliest Warmer Substage of the Würm (Amersfoort) in Poland	Periglacial Commission and Subcommission of Paleogeographical Maps and Atlas
1971	Belgium, France	IGU joint Symposium	Rôle du ruissellement dans le modelé périglaciaire	
1973	Yakutsk	II Permafrost Symposium	The glacial complex in the notion of the late Cenozoic cold ages	paper prepared for Symposium, *Biuletyn Peryglacjalny* 24/1975

French summary "Du caractère périglaciaire de la Pologne Centrale") and „Zagadnienia poligenezy rzeźby w pracach nad geomorfologiczną mapą Polski" (in *Przegląd Geograficzny*, 25, in Polish, with French summary "Problème de la polygenèse du relief dans les travaux sur la carte géomorphologique de la Pologne"). The convincing arguments for using the concept in the rest of Poland we can found in "Coup d'oeil sur la Pologne périglaciaire" (*Biuletyn Peryglacjalny*, 4), where JAN DYLIK (1956) interpreted the intensity and nature of Pleistocene periglacial phenomena in relation to the extents of glaciations. The idea was presented by him at the XVIII International Geographical Union Congress in Rio de Janeiro in 1956, during which he was appointed chairman of the IGU Commission on Periglacial Geomorphology, where he served four terms. When J. DYLIK started the coordination of international works, periglacial investigations in Łódź were already advanced.

The titles of papers given in table I allow to see the evolution of JAN DYLIK research interests, although apparently it is far from a complete picture of his achievements. In my view, priority should be given to: 1. periglacial structures and frost action in Pleistocene; 2. aeolian activity; 3. slope deposits and slope development under periglacial conditions; 4. thermoerosion and thermokarst; 5. the notion of "periglacial" (adj.) – distinguishing between zonal and climatic approach; 6. cyclicity of periglacial conditions; 7. spatial differentiation of periglacial phenomena and controlling agencies; 8. climatic changes during the last cold stage. JAN DYLIK was particularly attracted to slope processes. The role and more importantly the nature of the processes (congelifluction, slope wash as a zonal process, frost creep) under periglacial conditions were studied at all the most famous sites investigated by him, such as Józefów, Góra św. Małgorzaty, Walewice (Fig. 1).

I think that it is useful to list the main directions of periglacial research initiated by JAN DYLIK which were strictly connected with the international tasks and evidently crucial to the development of geomorphology in the Łódź academic centre. The titles of doctoral dissertations on periglacial morphology supervised by Professor DYLIK are given in table II. Professor initiated investigations of periglacial structures and deformations, aeolian processes, slope processes, soil horizons, fluvial processes, etc. Only detailed investigations of landforms, deposits and processes emerged a picture of environment varying through space and time. We still carry on these studies and deal with the problems pointed by JAN DYLIK. In the fiftieth anniversary of the IGU Commission on Periglacial Research and, at the same time, periglacial research in Łódź, we are far from the full recognition of Pleistocene periglacial environments of middle Poland which, according to the map compiled by JAN DYLIK, lies exclusively within the realm of periglacial denudation.

Doctoral dissertation on periglacial morphology supervised by JAN DYLIK

Table II.

Year	Name	Title (of summary)	*Acta Geogr. Lodz.* No/Year
1960	Julia Kolasińska	Classification génétique des structures de mollisol	10/1962
1961	Tadeusz Klatka	Champs de pierres de Łysogóry, origine et âge	12/1962
1964	Halina Klatkowa	Vallons en berceau et vallées sèches aux environs de Łódź	19/1964
1964	Józef Jersak	Stratigraphie et génése des loess aux environs de Łódź	20/1964
1964	Tadeusz Krzemiński	La percée de la vallée de la Warta par le Plateau de Wieluń	21/1965
1965	Barbara Manikowska	Les sols du Pléistocène supérieur aux environs de Łódź	22/1966
1969	Henryk Gawlik	Morphologie du bassin de Szczerców	26/1970
1972*	Julia Kolasińska	Phénomènes morphogénétiques du climat froid de la presqu'île de Kola	30/1972
1972	Jan Goździk	Origin and stratigraphical position of periglacial structures in Middle Poland	31/1973
1973*	Józef Jersak	Lithology and stratigraphy of the loess on the Southern Polish Upland	32/1973
1973	Jadwiga Wieczorkowska	l'évolution des versants des Collines de Romanów à la lumière de la paléogéographie de la région	35/1975
1973	Krystyna Turkowska	Processus fluviopériglaciaires sur le fond de la morphogénèse de la vallée de la Mroga	36/1975

* post-doctoral dissertation

JAN DYLIK view on a remodelling of glacial relief and the formation of new relief of periglacial denudation was the subject of discussions and much controversy. Today it is clear that the picture and significance of periglacial morphogeny is much more complex than it was previously assumed. The correct understanding of the role of periglacial phenomena operating on a glacial surface still remains one of the main problems of Polish geomorphology. Discussions during the following meetings recently organized in Łódź have favoured considerations on the criteria of the ap- praisal and the role of periglacial morphogeny in middle Poland:

1. 4–5 May 1995 – national conference "Polygenic relief in Poland" dedicated to Professor HALINA KLATKOWA to celebrate the fiftieth anniversary of her scholarly work at Łódź University (TURKOWSKA, *ed.*, 1995, 1996);

2. 7–9 May 1997 – national working conference on "Middle Plenivistulian deposits of small river valleys in middle Poland" (TURKOWSKA, *ed.*, 1997);

3. 7–8 December 1998 – national conference dedicated to the memory of Professor JAN DYLIK in the 25th anniversary of his death (TURKOWSKA, *ed*., 1998);

4. 27–30 September 1999 international symposium on "Periglacial Environments: Past, Present and Future", which was organised on the suggestion of Professor ALBERT PISSART and Professor JEF VANDENBERGHE on behalf of the IGU Commission on Climatic Change and Periglacial Environments, to celebrate 50 years of its activity, in 1956–1972 headed by JAN DYLIK (TURKOWSKA, *ed*., 1999).

EXAMPLES OF INDICATORS AND CRITERIA USED IN THE ASSESSEMENT OF THE PERIGLACIAL PLEISTOCENE ENVIRONMENT OF MIDDLE POLAND

The sites demonstrated by the autor during field conference excursions in 1997 and 1999, situated in the area of detailed study by JAN DYLIK, are discussed in the present paper. The effects of periglacial morphogeny in interfluve areas have been presented on the basis of examinations of the residual hillock at Janów (252 m a.s.l.), while zones of periglacial accumulation – illustrated by the drainage basin of the upper Mroga River, primarily of the valley of the Mrożyca at Niesułków. The map (fig. 1) shows also other, the most important localities used in JAN DYLIK periglacial research and some sites investigated by his collaborators and disciples, particularly these known while acting as chairman of the IGU Periglacial Commission. It is published here in order to remind studies carried out a quarter of a century ago, and to draw the attention to the future directions (fig. 2), and possibly to the present findings. Obviously a picture of periglacial investigations conducted in the edge zone of the Łódź Plateau is not complete in the article. Comments on the role of the periglacial factor in a broader area of middle Poland are also based on the analysis of 27 sheets of the Detailed Geological Map of Poland 1:50 000, following the work by KLATKOWA (1994), presented during the Polish–French session (Łódź, May 1990).

JANÓW – PERIGLACIAL FEATURES AT WARTIAN GLACIAL SURFACES

The Janów residual hillock of the Łódź Plateau (252.0 m a.s.l.) is produced of Wartian fluvioglacial deposits. West–southward there is the highest point of the Plateau (282.0 m a.s.l.) that is a junction where watersheds of the first order (Wisła–Odra) and the second order (Bzura–Pilica) meet. North, within the Bzura drainage basin expands the edge zone, which descends with four levels towards the Warsaw–Berlin Pradolina. For Janów area, the first detailed cartographical interpretation of periglacial morphogeny was compiled by A. DYLIKOWA and H. KLATKOWA

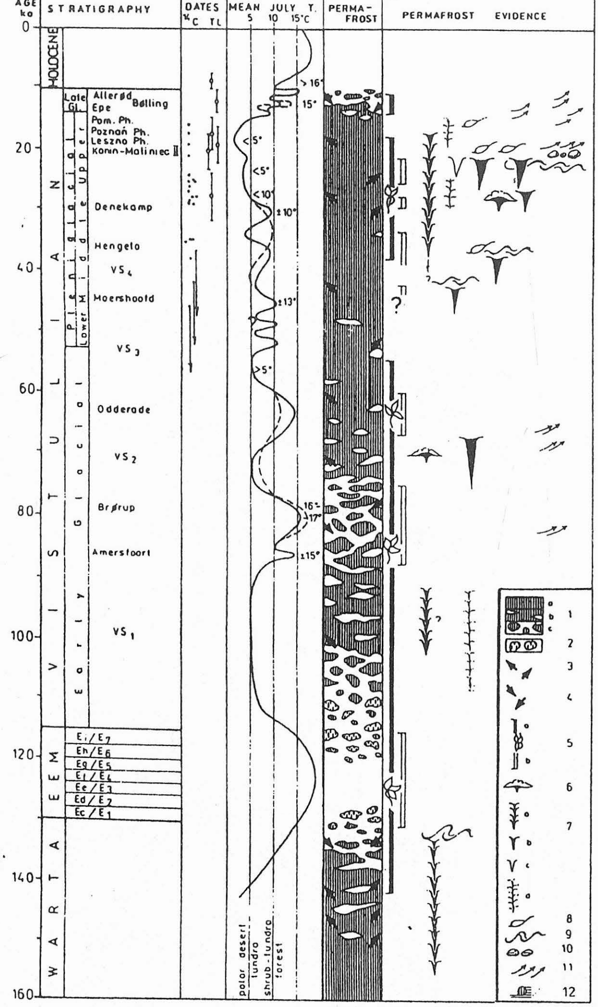

Fig. 2. Presumable occurrence of Pleistocene permafrost in Middle Poland during the last 150 000 years, after KLATKOWA (1996; on the basis of her findings and numerous works, among others by GOŹDZIK, JANCZYK-KOPIKOWA, JASTRZĘBSKA-MAMEŁKA, JERSAK, KOZARSKI, MARUSZCZAK, MOJSKI, ROTNICKI, TOBOLSKI)

columns: I – absolute age; II – stratigraphy; III – ^{14}C and TL dating; IV – thermal curve of the warmest month for Middle Poland (after KOZARSKI 1991, with KLATKOWA's modification – dashed line); V – probable occurrence of permafrost: 1. perennial: a – continuous, b – discontinuous, c – sporadic; 2. seasonal; 3. tendencies for aggradation; 4. tendencies for degradation; VI – evidence and indicators of permafrost existence: 5. vegetation cover: a – in small closed depressions, b – in open systems (e.g. alluvial plains); 6. intrusive structures – hydrolaccoliths, pingo, 7. polygons: a – syngenetic ice-wedge casts, b – epigenetic ice-wedge casts, c – sand– wedges, d – fissures of sesonal infilling; 8. congelifluction (solifluction) structures; 9. involutions; 10. gravelly-stony pavement; 11. intense aeolian activity; 12. thermoerosion phenomena in *Biuletyn Peryglacjalny* (1956). On the map (fig. 3), we can see a fragment of two highest levels of the edge zone, it of 200–220 m and other of 180–200 m a.s.l. (Pl. 1). These authors interpreted steps of the edge zone of the Łódź Plateau as the effect of slope equiplanation under periglacial

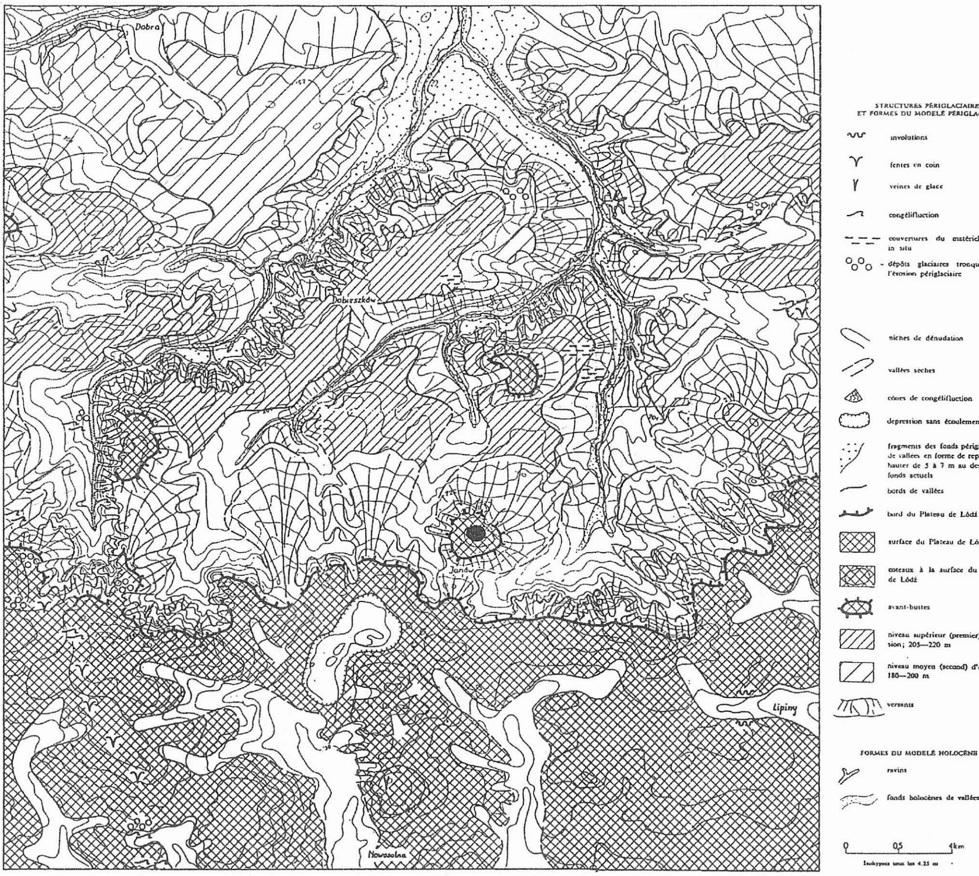

Fig. 3. Periglacial mode of relief development of the Janów environs interpreted by A. DYLIKOWA and H. KLATKOWA (1956)

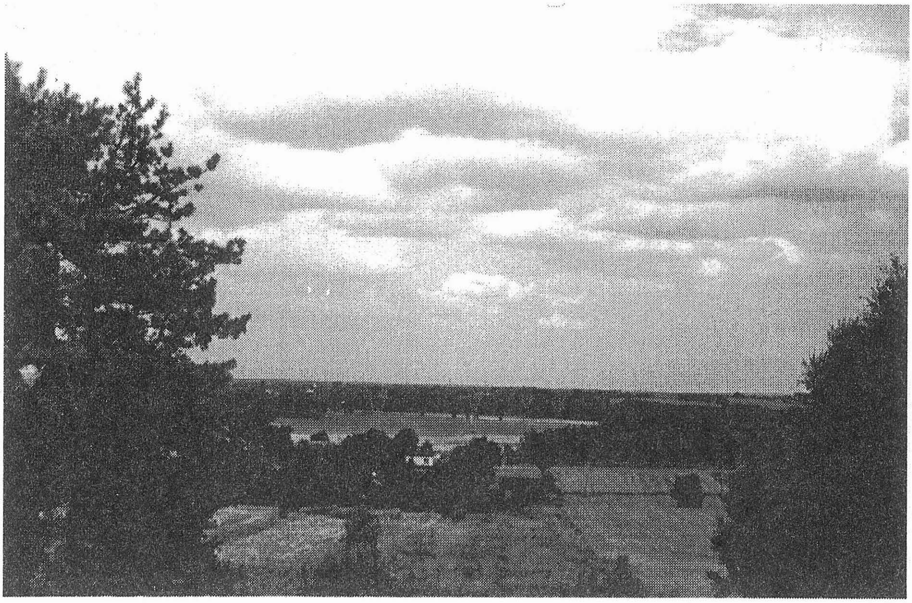

Photo by K. Turkowska, 1999

Pl. 1. Janów. View from a residual hillock northwards

conditions. Later, in 1972 KLATKOWA, on the basis of documented glaciotectonic zones, which generally relate to fronts of the steps, associated development of the steps with a "jumping" transgression of the Wartian ice sheet, resulting from transverse dislocations within Cretaceous deposits. Such a glacial mode of development is still accepted. Apart from this general theory, a remodelling due to periglacial conditions is obvious.

Generally, dry and river systems of valleys are the most predominant and best recognized feature of periglacial relief of the edge zone region. The Janów area is dissected by the Moszczenica River system. In river valleys, up to 7 m above the present-day valley floors almost continuously a high valley level occurs, which corresponds to a bottom of valleys of Upper Plenivistulian age. It constitues the base for the main generation of periglacial dry valleys and is undulated with their younger generation (Late Vistulian). Fresh erosional relief is present also on the interfluve sides, between succesive steps, as can be seen on the photo 2 (Pl. 2).

The valley network in the discussed zone is of post-Wartian age, though adjusted to glacial forms. In all the valleys of streams flowing towards the middle Bzura River it is possible to distinguish extensive, mostly glacial in origin, sections situated on flat surfaces of the edge steps and

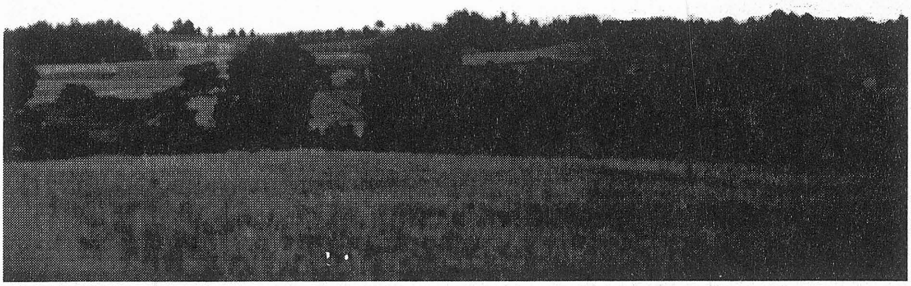

Photo by K. Turkowska, 1999

Pl. 2. Janów. View from a residual hillock eastwards of slope between the Łódź Plateau and the Smardzew level

erosional sections that cut their fronts. From the present state of knowledge follows also the common relationship between dry valleys and post-Wartian depressions filled with Eemian and Early Vistulian deposits. The investigations of their foundations and infillings helped to recognize both the stratigraphy of Late Pleistocene and the cyclicity of periglacial processes. Among many sites which document the disappearance of post-Wartian depressions in the Eemian Interglacial and Early Vistulian, and then development of denudation valleys, one should mention first of all the Rudunki site (Fig. 1).

Generally, in the edge zone of Łódź Plateau, the balance of the effects of valley processes is clearly in favour of erosional and denudational activity, which is indicated by the removing of most deposits. Slopes subjected to planation under periglacial conditions cover ca 45% of the area. A record in the Mroga River valley shows the major phases of Late War- tian, Lower Plenivistulian and Late Vistulian erosion, which changed the valley configuration as well as pattern and extent of valley network. In consequence, in some drainage basins, a valley network is up to 6 times longer than a river network, e.g. in the Czarnawka River system, the lenght of valley axes is 112 km, while the lenght of streams is 21 km; the density coefficients 3.34 and 0.62 km/km^2 respectively.

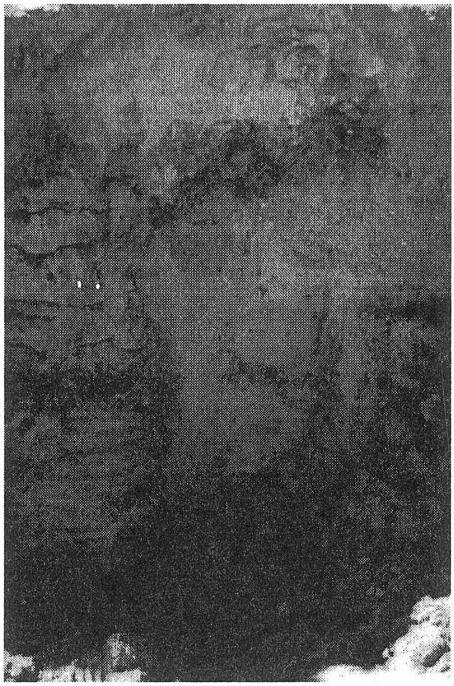

Photo by K. Turkowska, 1999

Pl. 3. Janów. Structural properties of fluvioglacial deposits at the top of a residual hillock dissected by frost crack of primary mineral infilling and festoon pattern of the bottom of illuvial horizon between two levels of periglacial deformations

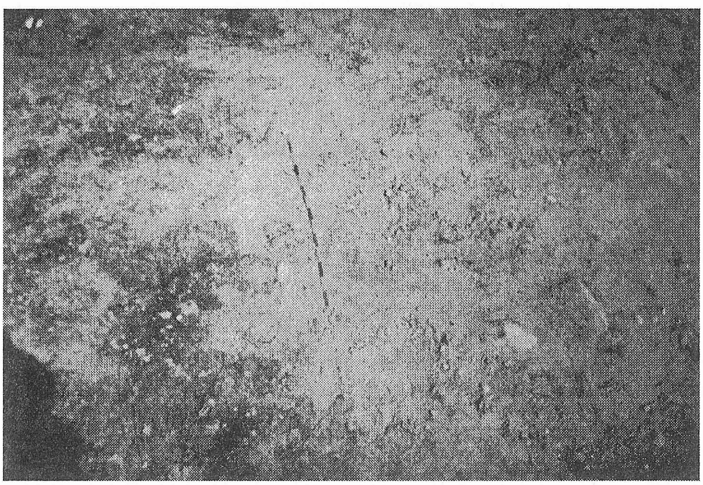

Photo by K. Turkowska, 1999

Pl. 4. Janów. Surface of a residual hillock without humus horizon of present-day soil, traces of stones arrangement as circles, numerous wind-worn stones

In the old map of a periglacial modelling of the Janów environs, the periglacial deformations are common on the interfluve area (Fig. 3). According to the author, on the hillock surface, we have at least two generations of periglacial, post-Wartian deformations: 1. the older one is represented by sand-wedge polygons developed in fluvioglacial sands and gravels (Pl. 3) and 2. stone pavements with very common wind-worn stones, frost heaving indicators and, probably, remains of stone polygones (Pl. 4). These all stones (maximum 1 m in diameter) should be considered the residuum of primary till cover over fluvioglacial deposits. The periglacial deformations are separated by remains of residual (Eemian?) soil – its eluvial and iluvial horizons with strongly irregular bottom.

Thus, we have to remember that residual glacial or fluvioglacial surfaces reveal periglacial desintegration covers, wind-worn stones and other periglacial deformations commonly in the entire area of middle Poland (see KLATKOWA, 1996). These are the global effects of all post-Wartian periglacial cycles, generally difficult to separate and to evaluate.

PERIGLACIAL FEATURES IN THE VALLEY; A CASE OF THE MROŻYCA RIVER IN NIESUŁKÓW

The significance of the valley of the Mrożyca River, where Professor DYLIK's investigations were most intense while formulating the concept of periglacial morphology, is emphasized by the fact that during the INQUA Congress, in Poland in 1961, four sites (Niesułków, Działki Niesułkowskie, Nowostawy, Jabłonów) were located there (Fig. 1) (DYLIK, 1961).

Valley asymmetry is an outstanding feature of the configuration of the Mrożyca valley at Niesułków (Fig. 4). The left, southwestern slope is gently inclined and even (Pl. 5), while the right northeastern slope is steeper and more varied (Pl. 6), with a distinct flat segment at the height of 155–160 m a.s.l., from ca 10 m above the valley floor at the terrace margin to 15 m at the top. Differences are due to the concaveness of a transverse profile, which is a typical feature of small valleys produced under cold climatic conditions. It is also easy to notice the undulation in a long profile of the valley level, largely caused by different intensity of transverse accumulation. The valley level is here merely from 100 to 150 m wide. It expands and penetrates into concomitant dry valleys. These forms are interspersed with fresh erosional cuttings, so called valley gullies. The terrace margin is cut with hillslope gullies or small denudation forms, fans of which encroach on the valley floor (Pl. 6).

The marginal zone of the Mrożyca erosional valley is, like other valleys of the edge zone, filled up with rhythmically layered sandy-silty deposits of about 10 m in thickness. No organic matter has been found. These deposits are free of $CaCO_3$. Their fabric is shown in photographs 7

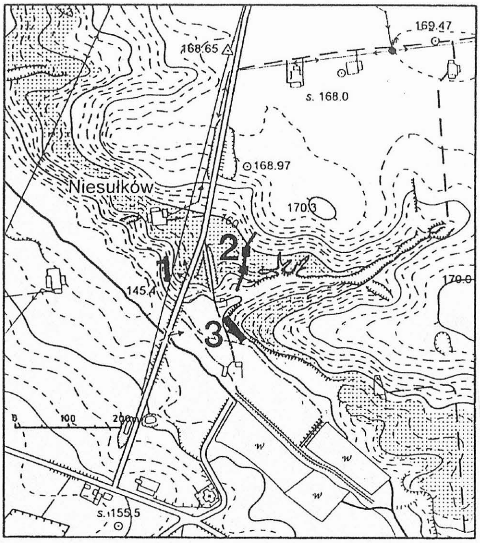

Fig. 4. Configuration of the Mrożyca valley in the vicinity of Niesułków

1. approximate extent of the high valley level; 2. location of the stops on the excurssion I route

and 8. Bipartity of deposits was recorded. At the bottom, a series of thinly laminated sandy-silty deposits occur. Above, a rhythmically stratified series of alternating thin beds of vari-grained sands and thicker beds of fine sands and silts lie unconformably. TL age estimations for five samples from above and below the unconformity surface (Pl. 8) show that the change in valley accumulation took place approximately 30 ka BP.

It seems plausible to relate the formation of the lower series with standing water conditions alternating with slight water discharge. The upper series was produced in much more complex sedimentary environments. Erosional surfaces, synsedimentary and postsedimentary deformations occur frequently, however classical frost structures are absent. Beds with an admixture of coarse sands and revealing cross-lamination are explained by periodically high flow dynamics in the dry valley, occasionally by intense, but evidently short flood flow in the main valley. The predominant sandy-silty and silty deposits testify to quieter and longer flow of cold waters (a high content of grains in suspension), mainly due to snow melt, and aeolian deposition involved. Similar conditions repeated, which is confirmed by a characteristic rhythmicallity of the series. Both, the index after Krumbein (>0.6) and the content of RM grains (over 40%) point to the intensity of aeolian processes and help to date the series: distinct aeolian features on grain surfaces were many times reported from valley infillings of Plenivistulian age and interpreted as an evidence of cold desert (see e.g. GOŹDZIK, 1981). Exfoliation of grain surfaces is

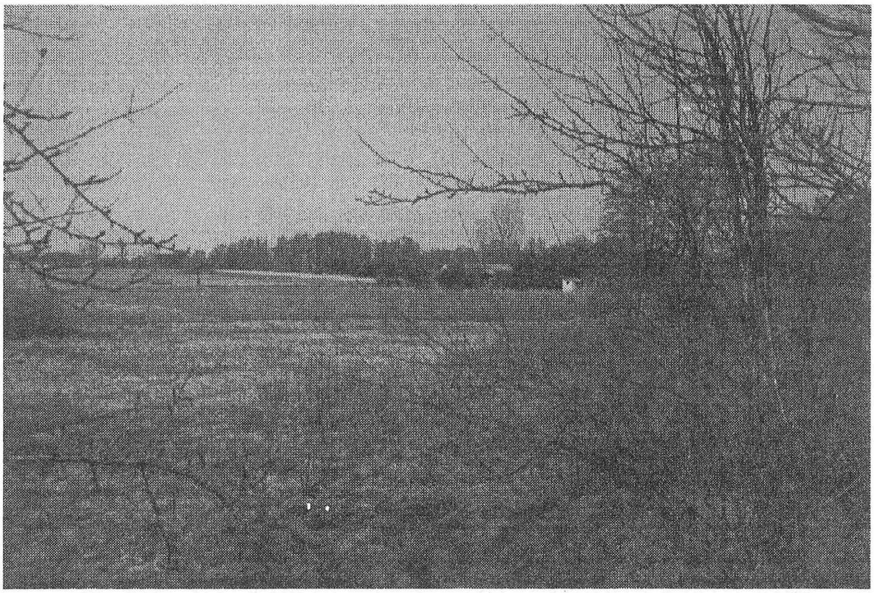

Photo by K. Turkowska, 1999

Pl. 5. Niesułków. Western slope of the Mrożyca River valley

Photo by K. Turkowska, 1999

Pl. 6. Niesułków. Eastern slope of the Mrożyca River valley according to WORONKO due to the provenance from the active layer with frequent freeze-thaw cycles *(vide* TURKOWSKA, *ed*., 1997).

Rhythmically stratified sediments similar to these of Niesułków are typical for other valley infillings in the Łódź region (TURKOWSKA, 1988). Major deposits filling valleys are formed by that polygenic sandy-silty series (slope, proluvial, flood, aeolian deposits) which attains a thickness of 20 m, while its lateral extension is incomparably larger that other sequences deposited under periglacial conditions. Without doubt this series posesses the most comprehensive literature and was particularly invesß tigated by JAN DYLIK. In river valleys of the Łódź region, silty-sandy or sandy-silty deposits of the discussed series form a so-called high valley level. They are a main component of Vistulian infillings of valleys, and their volumes exceed the volumes of older series, preserved exclusively locally, as well as of younger series. Analyses of a sedimentary environment point to its differentiation, both within the valleys themselves, along transverse and longitudinal profiles, and between valleys, according to their size, direction, configuration etc. Polygenic nature of the series which is composed of slope, flood, channel, overbank, lake, aeolian, etc. sediments is beyond doubt. The series is bounded by erosional surfaces. The lower surface, which in the discussed area is known mainly from borings while directly exclusively from the slope-near zones, was dated as the Lower–Middle Plenivistulian and related to the deepest post-Wartian valleys. The upper surface is manifested by the change in the lithology and is widely known to the author and interpreted as the Upper Plenivistulian in age, directly before the main transgression of the Vistulian ice sheet.

Accumulation of the presented deposits led to the serious lowering of the older relief (generally of Early and Middle Plenivistulian age) or occasionally to its planation. Lithological features of the series in drainage areas of complex configuration, such as the Mroga basin, to which the Mrożyca belongs, promoted the formation of young Holocene erosional forms, predominantly on the eastern valley sides; the gully system in Niesułków is here a case in point. Turning to the question of asymmetry of the Mrożyca valley, the hypothesis may be put forward that in the Plenivistulian, despite a higher insolation on the south and west facing slopes, runoff and erosion processes were relatively more intense and efficient. In the Mroga valley, similar in morphology, wash and congelifluction deposits are greater in thickness and extension, and generally are better preserved on the east facing slopes. The left west facing slope reveals heterogenic nature, often contains buried terraces, while its present-day shape has resulted from slope processes in the Late Vistulian which were here particularly intense (TURKOWSKA, 1975).

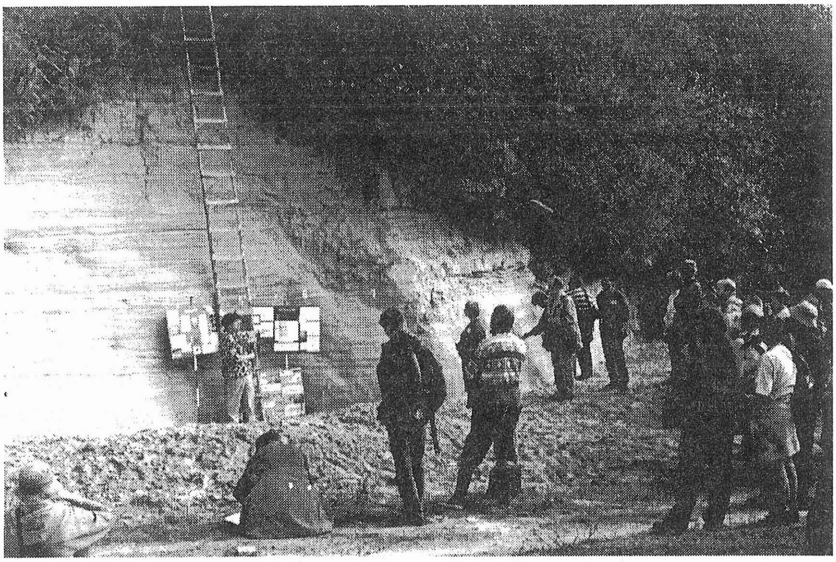

Photo by J. Twardy, 1999

Pl. 7. Niesułków. Structure of the Mrożyca valley infill at the dry valley outlet

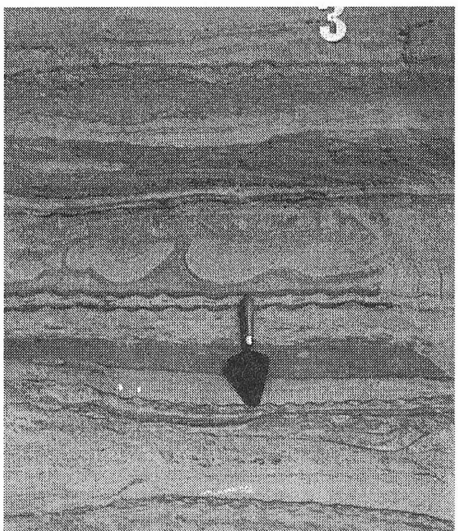

Photo by J. Twardy, 1999

Pl. 8. Niesułków. Complex structure of rhythmically layered series in the Mrożyca valley

CONCLUDING REMARKS

The discussed examples allow to formulate the following remarks on the criteria used to assess the role of periglacial morphogeny in middle Poland as well as the role itself:

1. correlative deposits fragmentarily evidence periglacial morphogeny. These are only part of the effects of weathering and transport processes, the smaller the farther from erosional-denudational bases. It is therefore incorrect to identify the effects of periglacial morphogeny only with periglacial covers. This comment relates to the whole bulk of deposits which survived (possibly excluding the subsidence zones) and particularly to their surficial sequence. The effects of periglacial morphogeny should not be inferred exclusively from geological mapping. The assessment of the role of a periglacial factor in middle Poland made by KLATKOWA (1994) is thus not complete for methodological reasons. Another aspect of the question is reliability and comparability of sheets of the Detailed Geological Map of Poland 1:50 000. In the analysed area, many authors ignore the effects of the periglacial cycle, either deliberately (to small scale of the map) or because of the insufficient knowledge of climatic and dynamic geomorphology;

2. the balance of the effects of periglacial processes on middle Poland is in favour of erosion and denudation. Intensity of denudational activity depended on the configuration of initial glacial relief, and that is why on the slopes of glacial valleys and of the edge zone of the Łódź Plateau, beautifully developed, extensive systems of periglacial valleys are met with. On the example of a map of the Janów environs one may state that geomorphic maps are more complex source of information about periglacial morphogeny, than the geological one;

3. effects of periglacial destruction survived not only as erosional and denudational slopes or as hiatus and unconformities within periglacial sequence, but also in textural properties. Examples of the latter are: content of wind-abraded grains in Upper Plenivistulian fluvial series comparable to this in dune sediments, common occurrence of wind-worn stones on till and fluvioglacial plains of middle Poland, and also stony pavements, epigenetic polygons of thermal contraction cracks and other disturbances, such as up-freezing traces. These are the effects of all cycles of periglacial morphogeny. We know that their number and intensity depended on an age of the analysed surface;

4. the entire glacial area of middle Poland was remodelled due to periglacial conditions, although the effects vary and in the grater part of the territory they are impossible to quantitative assessment because of the lack of most correlative deposits. The same causes difficulties in concluding about paleogeographical conditions of the Vistulian, because these investigations need the dynamic approach being much more complex;

5. geological maps and associated geomorphological sketches do not provide the reliabe data for the assessement of the effects of periglacial morphogeny.

According to the autor, the present state of knowledge about Pleistocene periglacial processes and their morphogenetic effects corroborates the concept of JAN DYLIK on the relief polygenesis in middle Poland, and discrepancies between its former and current understanding are of a quantitative nature. After the Wartian Glaciation, which was here the last glacial event, the discussed area was affected by various modifications of a periglacial climate for about 120 ka years, whereas two main episodes of a temperate climate (Eemian and Holocene) were short and had only local effects. When assessing the role of periglacial environment, the dynamic approach and the awareness that merely insignificant fragments of the products of periglacial processes have survived are apparent. It seems necessary to stress once again that more corrrelative deposits was removed and we have no sufficient data for the quantitative assessment and for the detailed paleogeographical reconstructions. The idea of the periglacial cycle is not the intensity of processes but its long duration, and one of the main effects is the transformation of closed depressions, which after the Scandinavian ice sheet retreat were local denudational bases, into the open valley systems present up today.

Thus, it is certain that the theory of JAN DYLIK about the periglacial nature of middle Poland relief is still up-to-date.

Translated by D. Dzieduszyńska

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