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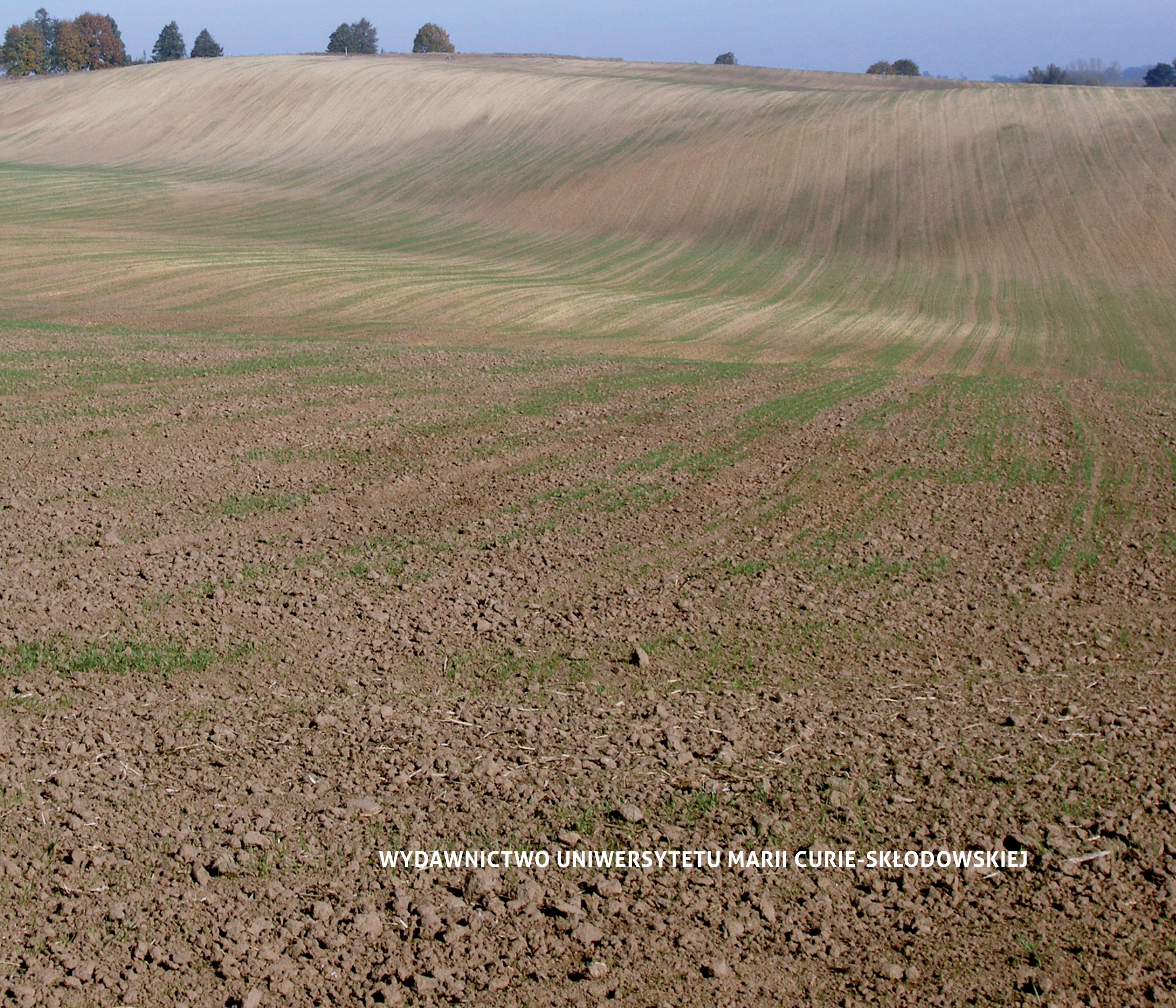

WYDAWNICTWO UNIWERSYTETU MARII CURIE-SKŁODOWSKIEJ

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Spis treści

Summary

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Outline of the problem

The soils that formed on loess in the central part of the European loess belt are primarily zonal clay-illuvial soils (e.g. Bednarek, Prusinkiewicz, 1997; *Soil Atlas of Europe*, 2005; *Systematyka gleb Polski*, 2011; Białousz, 2015; Marcinek, Komisarek, 2015), among soils described as Luvisols, according to WRB criteria, commonly dominate (Dreissen et al., 2001; IUSS Working Group WRB, 2006). The main diagnostic horizons of these soils are endopedons: the higher one in the Et-luvic profile and the lower one in the Bt-argic profile. However, usually only the latter is widely documented in profiles due to the widespread strong erosion of the recent soil cover. Owing to the properties of the parent material, considerable elevation differences in loess areas as well as the inappropriate way of their utilisation, the structure of Luvisol profiles often diverges from the classic horizon sequences of a forest soil (O-A-Et-Bt-C-Cca). In modern times, these are usually agriculturally used, truncated soils, co-occurring with moderately eroded or even highly eroded soils (e.g. Turski, Słowińska-Jurkiewicz, 1994; Klimowicz, Uziak, 2001; Rejman, 2006; Paluszek, 2010b; Gałka, Dębicki, 2014; Rodzik et al., 2014). In extreme cases of very strong erosion, on the site where these soils originally occurred, soils with a simple profile (ACca-Cca) are documented instead; they are described as post-Luvisol loess pararendzinas (Turski et al., 1991; Turski, Słowińska-Jurkiewicz, 1994). A characteristic feature of loess areas is their original undulation reflected in the soil cover and often taking the form of a mosaic with different degrees of soil preservation: from complete, full-profile soils to highly eroded, simple soils. This mosaic arrangement is additionally enriched by the presence of colluvial soils documented within concave landforms that developed on redeposited soil material.

Luvisols formed on loess and loess-like sediments genetically related with them are a research subject of soil scientists as well as palaeopedologists and Quaternary geologists. The profiles of Luvisols are a subject of classic pedological investigations: both primary research concerned with the soil origins (e.g. Turski et al., 1973; Turski, Słowińska-Jurkiewicz, 1994; Turski, Witkowska-Walczak, 2004; Bartmiński et al., 2010; Drewnik et al., 2014; Glina et al., 2014) as well as specifically oriented, applicable studies (e.g. Dechnik, Dębicki, 1980; Rejman, 2006; Paluszek, Żemborwski, 2008; Paluszek, 2010a, 2010b, 2013; Rejman et al., 2014), or studies reflecting a wider context related to the typology and classification of clay-illuvial soils (e.g. *Systematyka gleb Polski*, 2011; Kabała, Musztyfga, 2015; Marcinek, Komisarek, 2015). These soils are also a record of the history of the environment, its evolution and transformations caused by natural and anthropogenic factors (e.g. Kowalkowski, 1990, 1991; Manikowska, 2002b; Konecka-Betley, 2009). Both groups of researchers mentioned above often describe these soils as recent or modern soils, which is related to their location just beneath the topographic surface and the undoubtedly active impact of soil-forming processes (Bednarek, 2002; Manikowska, 2002b). However, describing such soils as modern is quite an oversimplification. Soil science literature emphasises that an incorrect genetic interpretation can contribute to a mistaken assessment of the impact of various environments on soil-forming processes, which may lead to the incorrect assignment of soils in the soil classification system (cf. Bednarek, 2008; Kabała, Musztyfaga, 2015). On the other hand, palaeogeographers and stratigraphers of the Quaternary frequently marginalise these soils and regard them as age markers strongly linked with the Holocene (Fig. 1) that merely closes the top of Pleistocene soil-loess sequences in stratigraphic tables (Maruszczak, 1991b, 2001; Dolecki, 2002; Jary, 2007; Marks et al., 2016). The significance of these soils in palaeoenvironmental investigations clearly increases in the case of studies on the evolution of the relief of loess areas in the Late Glacial and Holocene, particularly in conjunction with attempts to reconstruct the subsequent phases of human activity (e.g. Kowalkowski, 1990, 1991; Śnieszko, 1995; Schmitt et al., 2006; Dotterweich, 2008; Dotterweich et al., 2012; Superson et al., 2012).

The results of palaeopedological and pedostratygraphic studies, summarised by Maruszczak (1991b, 2001), Jersak et al. (1992), Śnieszko (1995) and Konecka-Betley (2009), confirm that the age of surface loess soils in Poland goes back further than the Holocene, at least to the Late Glacial (Fig. 1). Such a conclusion corresponds with the general conviction about the age of soils in Poland in areas built of the Youngest Vistulian sediments (Kowalkowski, 1990, 1991; Bednarek, 1991; Manikowska, 2002b; Konecka-Betley, 2002; Degórski et al., 2013). In the loess upland in Poland, the beginning of the activity of soil processes is linked with the end of the accumulation of the youngest loess, occurring already in the periglacial environment of the final stage of the Upper Pleniglacial and throughout the Late Glacial, i.e. in a period encompassing at least the last 16 thousand years. The fluctuating improvement of climate and vegetation conditions that began at that time and continued in the Holocene contributed to the formation of the soil cover with zonal soils, among which the forest Luvisol type is the dominant one.

Due to the formation of loess soils in changing environmental conditions over a relatively long period of time (more than ten thousand years), palaeopedological literature assumes that these are surely polygenetic soils; hence they should be described as Late Glacial-Holocene soils (Kowalkowski, 1990, 1991; Manikowska, 2002b; Konecka-Betley, 2009). In loess areas, the development of the soil cover is commonly linked with the dominance of the lessivage process that is responsible for the development of the particular sequence of soil horizons (Driessen et al., 2001, *Systematyka gleb Polski*, 2011). Although the mechanism of Luvisol formation is relatively well understood (Duchaufour, 1948; Aubert, Duchaufour, 1956; Zasoński, 1974), it is not the case with the evolution of these soils over time, i.e. from the initial synsedimentary soil processes (Upper Pleniglacial), to the periglacial period (Late Glacial) and the climatically varied Holocene, up to the modern times, or even the most recent times. Soil science literature frequently argues for the Holocene age of these soils, which is mainly explained by the change of climate, vegetation and soil conditions progressing from the end of the Glacial to the Optimum correlated with the Atlantic period (e.g. Dobrzański i in., 1973; Czępińska-Kamińska, 1987; Kowalkowski, 1991; Turski, Słowińska-Jurkiewicz, 1994). Such an interpretation refers to the classic model of soil formation in accordance with the universal pattern of environment evolution (Iversen, 1958; Andersen, 1964, 1966) that illustrates the natural transformations of the soil cover as a consequence of changes of the climate and vegetation cover. However, such a pattern of Luvisol evolution does not account for several morphological characteristics documented in soil profiles because it is difficult to link the origins of these characteristics exclusively to Holocene pedogenic processes. Indeed, some earlier studies already stressed the correlation of soils formed on loess with the periglacial environment (e.g. Tomaszewski, 1953; Musierowicz et al., 1963; Turski et al., 1973; Uggla, 1976). Furthermore, several other publications on the origins of Luvisols in the modern moderate zone emphasise the occurrence of clearly relic morphological characteristics linked with the activity of cryogenic processes, which was indicated by, among other authors, Reuter (1962) and Uggla (1976), and then described in detail based on the primary research conducted by e.g. Van Vliet-Lanoë (1990, 1998), Górniak (1992, 1998), and summarised by Van Vliet-Lanoë et al. (2004), Konecka-Betley (2009) and Van Vliet-Lanoë (2010). The increased activity of frost processes, untypical of the Holocene environment in the loess upland area in Poland, as documented on macroscale, is demonstrated primarily by the characteristic segregated pseudo-layering (lamellae) frequently observed in the lower part of the accumulation horizon or the accompanying platy/lenticular structure that is continued as far down as the level of the parent material.

The model of Late Vistulian-Holocene evolution of the soil environment in loess areas is further complicated by the varied degree of soil preservation (from full-profile soils to degraded, simple soils) as well as their occurrence in diagenetic form as a result of being buried by younger colluvia, frequently of varying age. In such cases, the soil-sediment sequences reflect the complexity of climate, vegetation and soil changes in the post-glacial period, frequently occurring with the co-participation of human beings (e.g. Śnieszko, 1995; Müller, Thiemeyer, 2012; Poręba et al., 2012; 2013; Kühn et al., 2017).

In the light of the research results presented above, scientists still need to determine the age and the palaeoenvironmental significance of both full-profile and erosionally reduced loess soils as well as complex post-glacial soil-sediment sequences.

Various methods are employed in attempts to explain the uncertainties regarding the origins and age of entire soil profiles of Luvisols and the individual genetic horizons. For example, investigations aimed at explaining the mechanism of post-glacial soil formation were considerably aided by the micromorphological method, successfully used by scientists such as Zasoński (1974, 1975, 1983), Van Vliet-Lanoë (1990, 1998), Kühn (2003a, 2003b), Fedoroff et al. (2010), Kühn and Hilgers (2010), Müller and Thiemeyer (2012) and Kühn et al. (2017). The main advantages of this method is the possibility of an unambiguous genetic identification of characteristics observed on microscale, which then enables the reconstruction of subsequent stages of soil formation and, ultimately, enables their precise chronostratigraphic identification. In micromorphological investigations, concentrations of the clay fraction are regarded as key markers, frequently analysed in conjunction with other micromorphological characteristics showing the subsequent stages of soil evolution (e.g. Kemp, 1985, 1998; Kemp et al., 1998; Fedoroff et al., 2010).

Purpose, methods and object of the study

The main research purpose was to reconstruct the conditions of the formation of Luvisols in the post-glacial period, encompassing the Late Glacial and the Holocene, in the loess uplands in southern Poland. The investigations were conducted based on detailed micromorphological studies of profiles of surface and fossil soils at the selected, representative sites. Such investigations required the accomplishment of the following detailed objectives: a) identification of the set of micromorphological characteristics of the studied soil profiles along with their genetic interpretation; b) determination of the relative age of the diagnostic micromorphological characteristics; c) identification of the stratigraphic position of the specific soil horizons; d) preparation of the Late Glacial–Holocene model of the development of the analysed soils.

Detailed microscopic studies of Luvisols formed in the post-glacial period should provide an answer to the question: how visible is lessivage in the micromorophological record? And what is the mechanism of the formation of this type of soils? Several additional questions of a general nature were posed regarding the evolution of the soil environment in the post-glacial period:

- How is the transformation of the parent material (loess formations), transformed by postsedimentary pedogenic processes, reflected in the micromorphological record? Hence, do the lithogenic characteristics still occur in the profiles of the soils under study and what is their character? This question is closely linked to another one: To what extent do pedogenic processes influence the degree of preservation of older, not only lithogenic but also pedogenic characteristics that had developed earlier?
- Which soil characteristics are actually formed in modern times, and which ones are of fossil or relic character? What soil is represented by what we call recent soil and what soil should be regarded as fossil or relic soil? Is the currently documented morphological image of the soil profiles under study recent or is it more fossil or relic?

The micromorphological investigations focused on thin plates prepared from the material of the surface and buried soil horizons and soil-sediment sequences formed in the post-glacial period, encompassing the Late Glacial and the Holocene up to the modern times. The sites chosen for analysis were the sites where soil pedons were available for direct investigation and met the following criteria:

1) Parent material with similar lithology, where the following were distinguished:
   a) Upper Pleniglacial loess sediments of the last stage of the Vistulian loess-formation cycle, described in Poland as younger upper loess (Maruszczak, 1991b, 2001) and marked with the symbol LMg or L1 loess according to the universal "Chinese" loess nomenclature (Kukla and An, 1989), modified by Marković et al. (2008; 2015) and identified as L1LL1 (Fig. 1) and
   b) colluvial sediments, composed of material originating from the destruction of older soils that accumulated on the secondary deposit while burying the layer of younger upper loess.
2) Similar maximum and minimum duration of active soil-forming processes, i.e. encompassing the period from the end loess deposition, i.e. the last ~16 thousand years (Maruszczak 1991b; 2001; Jersak et al. 1992; Lang et al. 2003; Antoine et al., 2009) including the modern times, i.e. from the end of the Little Ice Age (end of the 19th and turn of the 20th c. – Mann, Jones, 2003; Matthews, Briffa, 2005);
3) Similar climate condition in the period of: a) accumulation of Upper Pleniglacial loess investigated at sites located in the loess regions of the transitional formation at its contact with the dry formation according to the division by Jersak (1973, 1985), b) post-glacial evolution of zonal soils belonging to the same taxonomic unit of type status, according to the criteria of the *Classification of Polish Soils* (*Systematyka gleb Polski*, 2011), i.e. in

upland regions with a continuous loess cover (Maruszczak, 1991a) (Fig. 2). The pedons selected for micromorphological investigations, varying in terms of morphology and degree of preservation of horizons, were divided into three groups:

a) surface full-profile pedons with all soils horizons well-developed, i.e. A-Et-Bt-C-Cca (2 sites – 3 profiles; Fig. 3; Table 1);
b) surface eroded pedons with at least one soil horizon preserved (3 sites; Fig. 4; Table 3);
c) pedons buried beneath a layer of colluvial sediments with the characteristics of younger soil transformations occurring in fossil and surface form (3 sites; Fig. 5; Table 5).

The selected soil profiles differ primarily with regard to the level of their morphological development; hence, eroded profiles and profiles buried beneath thick colluvial layers were also selected for investigation besides profiles of agriculturally used soils with a full sequence of horizons (Ap-Et-Bt-C-Cca). In accordance with the proposal by Turski et al. (1991), the following types were assigned to the group of reduced Luvisols: medium (Ap-Bt1-Bt2-C-Cca), highly (Ap-Bt2-C-Cca) and even very highly eroded (Acap-Cca). The above types of soil profile development are interpreted and classified by soil scientists in various ways. According to *Systematyka gleb Polski* (2011), the full-profile soils selected for investigation are typical Luvisols (subtype 5.1.1; PWt). The investigated soils belong to this subtype also according to the proposal of Kabała and Musztyfaga (2015). On the other hand, the simple eroded loess profiles correspond to poorly developed eroded soils (2.6; SY). This is the type of soils that was described by Turski et al. (1991) as post-Luvisol loess pararendzinas.

Laboratory analysis

The basic method of investigation used was micromorphological analysis that boiled down to the observation of microscopic preparations described as thin sections with an undisturbed structure of the sediments under study (e.g. Bullock et al., 1984; Stoops, 2003; Mroczek, 2001, 2008). Performing this type of analyses on the peculiar loess and soil material required taking a number of steps as part of fieldwork, laboratory work and desk studies.

Laboratory work primarily consisted of making thin sections prepared by the author in the sedimentological laboratory of the Department of Geoecology and Palaeogeography at Maria Curie-Skłodowska University in Lublin. The micromorphological analyses focused on material with an undisturbed structure. The detailed procedure for making thin sections follows the methodology presented by Mroczek (2008), referring to the procedure developed by Lee and Kemp (1992) and regarded as universal for clastic sediments. As a result of grinding and polishing, a collection of 50x70 mm thin sections with a thickness of 20–30 μm was obtained.

The desk studies encompassed compiling the results of fieldwork and laboratory work as well as microscopic investigations observations of the thin sections carried out using an Olympus BX 51 microscope integrated with digital image processing software (Motic Images Advanced 3.2).

Primary research was conducted at sites regarded by the author as representative for the purposes of micromorphological analyses. The selected sites already have geological and soil science documentation and partial micromorphological documentation (having the character of an expert opinion), pertaining primarily to the description of Pleistocene litho- and pedostratigraphic units.

A minimum of two microscopic preparations were made for each sample with an undisturbed structure. Microscopic observations of a total of 271 thin sections were conducted. The exact number of sections in the particular soil horizons is provided in Tables 2, 4 and 6. Their number depended mainly on the quality of the material sampled in the field (disturbed/undisturbed) and the degree of similarity of micromorphological characteristics observed in the first pair of preparations. More items were added to the collection of thin sections in cases where micromorphological results had already been published but micromorphological inferences needed to be verified owing to: 1) damage to older, damaged microscopic preparations, and 2) differences in the final genetic and palaeoenvironmental interpretations obtained using different methods.

The frequency of the occurrence of specific micromorphological characteristics is divided into ranges described as: isolated (<0.2% of the preparation area), numerous (0.2–2%), very numerous (2–5%) and widespread (>5%). This type of recording the frequency of characteristics in thin sections is commonly accepted as appropriate for presenting the results of analyses of thin sections made of geological sediments and soil material of varying age and origin (cf. Stoops, 2003; Mroczek, 2008).

Results of micromorphological analysis

The microscopic observation of the thin sections focused on identifying a total of 38 micromorphological characteristics. Their occurrence is presented in table form separately for full-profile soils, eroded soils and complex soil-sediment sequences (Table 2, 4 and 6). The documented micromorphological characteristics can be assigned to the following groups: microstructures, carbonate, clay-silt, ferruginous, ferruginous-manganese, organic and faecal. The documented characteristics show a wide range of occurrence variability, from isolated characteristics found in sections to widespread characteristics. Examples of the main, most frequently recorded micromorphological characteristics are shown in Figures 6 to 12.

The obtained study results

In order to reconstruct the conditions of Luvisol formation in the post-glacial period, encompassing the Late Glacial and the Holocene, micromorphological analyses were carried out of the selected soil profiles formed on the Upper Pleniglacial loess and on the material originating from the redeposition of this loess. Detailed microscopic investigations focused on surface soils and buried soils available for direct investigation at benchmark sites in the loess upland areas in Poland.

The reconstruction of the stages of environment evolution was possible thanks to the analyses of soils examined according to the chronosequence approach. Profiles with different degrees of maturity and preservation were selected for investigation. The selected profiles consisted of agriculturally used full-profile soils (Ap-Et-Bt1-Bt2-C-Cca) as well as soils reduced by erosion to varying degrees: from merely truncated to simple post-Luvisols having the character of initial loess rendzinas (Acap-Cca). The analyses also encompassed fossil loess soils constituting a record of the development of Late Glacial-Holocene pedogenic processes that were stopped as a result of burying by colluvial soils that, subsequently, were also transformed pedogenically. Therefore, the analysed group of soils was expanded to include sequences of colluvial soils (surface and fossil).

Microscopic analyses of thin sections (Table 2, 4, 6) made it possible to distinguish a total of 38 micromorphological features grouped in the following seven sets: microstructures, carbonate, clay-silt, ferruginous, ferruginous-manganese, organic and fecal. On this basis, the morphological development of the specific soils was described while maintaining the division into loess and colluvial soils. In each case, the soil types distinguished were analysed separately in a system of surface and fossil units.

The micromorphological characteristics documented enabled the identification of several processes responsible for the development of the soils under study. These processes were divided into three groups: lithogenic, pedogenic and diagenetic (Table 7). The largest group of characteristics is made up by the pedogenic set reflecting the activity of the following soil-forming processes: accumulation of organic matter, migration of carbonates, illuviation of the clay fraction with admixtures of silt and humus, reduction-oxidation changes, bioturbation as well as formation of soil aggregates. Lithogenic characteristics is a small group investigated in the horizons of the parent material of the soils under study, i.e. carbonate loess and colluvial soils. These characteristics reflect the sedimentation of deposits (aeolian, colluvial) as well as synsedimentary transformations recorded mainly in the microstructure type and development of the primary carbonate microforms. The third, also small groups of micromorphological characteristics is the diagenetic set represented by characteristics formed secondarily at the post-soil-forming stage, visible in the thin sections in the form of carbonate precipitates, redeposition of mineral material and cryogenic distortions.

The micromorphological investigations of the Late Vistulian-Holocene soil chronosequence showed that illuviation is the main soil-forming process recorded in the thin sections and influencing the development of the investigated soil profiles. Based on microscopic observations, three basic stages of lessivage were distinguished. Both the characteristic and unique lithological development of illuvial microforms is an indicator of these stages. The following illuviation stages were distinguished accordingly:

a) Late Vistulian – identified based on cryogenically deformed clay-ferruginous-humus microforms (the so-called Type I), recorded exclusively in the Bt2-BC horizon sequence of loess soils (buried and surface);
b) Holocene – its markers are microfoms disturbed by bioturbation, composed on homogeneous clay without admixtures of any other ingredient (Type II). These characteristics are common in the accumulation horizons in both loess and colluvial soils, as well as in the lower part of the Et horizon in the case of loess soils;
c) modern – different from both of the above, clearly humic-clayey (Type III), recorded in the form of continuous microforms recorded in the sequence of horizons closely linked with modern topographic surface; their occurrence is not limited to the accumulation horizon.

The above three generations of micromorphological characteristics of illuvial origin provided the basis for the evolution model of Luvisols formed on loess in the Late Vistulian-Holocene period (Fig. 14). Three main pedogenic stages – two natural and an antropogenic one – were distinguished in this model:

a) initial stage – of interstadial status, it occurred in the Bølling s.l., or even in its younger warmer period, i.e. the Allerød; it was linked with the formation of loess soils with a well-developed enrichment horizon of the illuvial type as well as, presumably, a well-developed organic horizon, perhaps even of the chernozem type, as indicated by the distinct admixture of humus recorded in illuvial microforms. This stage ended with the beginning of the Younger Dryas recorded in cryogenic deformations of illuvial microforms;
b) proper, Holocene stage – related to the formation of Luvisols with a full horizon sequence, including the eluvial (Et) and illuvial (Bt) horizon. This stage is recorded in both surface and fossil loess soils (Older Holocene) as well as in colluvial soils, currently buried. This stage ended with the beginning of intensified human activity in the early Middle Ages;
c) initial modern stage – related to the progressing anthropogenic pressure in loess areas, recorded in permanent deforestation and frequently inadequate agricultural utilisation favourable to intensive soil erosion as well as in the accumulation of the youngest colluvial layer. The permanent exposure of the top of the soil was probably the trigger for the youngest stage of illuviation and formation of new agriculturally used soils developing in the top part of the older, both loess and colluvial pedons.

The genetic identification of the individual micromorphological characteristics analysed in connection with the soil horizons made it possible to distinguish a group of modern characteristics (i.e. currently formed) and fossil characteristics (formed in different environmental conditions) (Fig. 13). Based on genetic identification, it was also possible to distinguish a group of relic characteristics: linked with the fossil complex in terms of age but co-occurring with the characteristics developing in modern times. This, in turn, enabled the identification of the age of the individual soil horizons regarded as the "data storage" of the soils. On this basis, it was demonstrated that:

a) the oldest part of the profile is the C horizon with relic characteristics inherited from the parent material (Cca horizon), developed already before the first illuviation stage. The lithogenic micromorphological characteristics of the parent material of both the loess and colluvial soils are entirely obliterated by younger pedogenic processes to the depth of the C horizon. In spit of that, in the case of the colluvial (buried and surface) soils, the pedo-relic micromorphological characteristics show unequivocally that the products of the reposition of older Luvisols with a well-developed diagnostic Bt-argic endopedon are the parent material;
b) the youngest part of the profile is the A epipedon, which records only recent soil processes that erase or mask the older micromorphological characteristics;
c) the memory of the endopedons depends on their location in relation to the top of the soil and the development of the neighbouring horizons. The highest genetic and stratigraphic value is represented by the lower horizon of enrichment Bt2 and transitional horizon BC, both recording two stages of illuviation in the Late Glacial and the Holocene. On the other hand, the genetically correlated Et and Bt1 horizons contain information about only one eluviation-illuviation stage: the Holocene illuvial microforms totally mask the older characteristics in the Bt1 horizon while the highly advanced eluviation totally impoverishes the material of the Et horizon.

Based on the above observations, it was shown that the soils that constitute a complex are a more capacious carrier of information about the evolution of the soil environment that the soils that constitute a pedocomplex. The former encompasses two separate soil units while the latter consists of at least two overlapping units where the older pedogenesis is masked by the younger one, which, in extreme cases, leads to the total obliteration of the older characteristics. Furthermore, it was concluded the rules presented above apply only to naturally formed soils, i.e. without any or with a minimal impact of human activity. The conducted micromorphological investigations demonstrated that, in modern times, similar anthropogenic initial soils have been formed in the top part of all the analysed profiles of both loess and colluvial soils. In these pedons, the younger pedogenesis is superimposed on the older one, giving it a relic character.

The selection of the study sites made it possible to carry out palaeopedological analyses in a chronosequence system encompassing the whole post-glacial period or relying on only the selected parts of this period. On this basis, paleoenvironmental inferencing was conducted in a system of the following chronosequences (Fig. 15):

a) equi-start, analysed based on the development of loess soils: surface, full--profile and buried by older colluvial sediments;
b) equi-ending, composed of surface soils: full-profile loess and colluvial soils, and initial soils formed in the top part of eroded loess soils;
c) transgressive without overlapping, analysed based on buried soils (loess and colluvial) compared with surface colluvial soils;
d) transgressive with superimposition, analysed based on surface loess soils (full-profile and initial formed in the top part of eroded soils) and colluvial (buried and surface) soils.

Using palaeopedological criteria, the soil units under study were divided into palaeosols and Neosols. The former are soils developed under environmental conditions different from the modern conditions; buried loess soils regarded as fossil palaeosols and buried colluvial soils meeting the criteria of relic palaeosols were assigned to this group. In the light of micromorphological analyses, Neosols are initial soils developed in modern times in the top part of the older, currently relic soils, both loess (full-profile and eroded) and colluvial.

Głównym celem badawczym recenzowanej pracy było odtworzenie warunków powstawania gleb płowych formowanych w okresie późnego glacjału i holocenu na obszarze wyżyn lessowych południowej Polski na podstawie szczegółowych studiów mikromorfologicznych. Autor przeanalizował gleby wytworzone na lessie w wybranych przez siebie stanowiskach badawczych z założeniem, że są one reprezentatywne dla wspomnianego obszaru. Główny cel pracy został skonkretyzowany poprzez określenie celów szczegółowych, które obejmują: (1) identyfikację cech mikromorfologicznych badanych gleb wraz z ich interpretacją genetyczną, (2) określenie wieku względnego diagnostycznych cech mikromorfologicznych, (3) określenie pozycji stratygraficznej poszczególnych poziomów glebowych oraz (4) opracowanie modelu formowania gleb późnoglacjalno-holoceńskich.

Cel badań oraz zakres przestrzenny i czasowy nie budzą zastrzeżeń. Za uzasadnione uważam wykorzystanie badań mikromorfologicznych w celu rozwiązania problemu następstwa genetycznego gleb lessowych południowej Polski oraz określenia poligenezy gleb. Autor ma wypracowany warsztat naukowy oraz doświadczenie upoważniające do podjęcia tego trudnego zadania. Niezależnie od wartości merytorycznej wyników analizowanych w pracy, oceniany manuskrypt sumuje wielką wiedzę, którą polscy uczeni wypracowali, prowadząc wieloletnie badania, w połączeniu z wynikami własnymi zawartymi w innych pracach autora. Opis wyników oraz dyskusja i wnioskowanie są dobrze osadzone w aktualnym stanie wiedzy w Polsce i na świecie.

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