

DUNES AS INDICATORS OF THE RESTRUCTURING OF HYDROGRAPHIC NETWORK OF RIGHT-BANK UKRAINIAN POLISSYA IN THE LATE PLEISTOCENE AND EARLY HOLOCENE

Keywords: late Pleistocene dunes, restructuring of hydrographic network, the Styр river

Introduction. The results of the years of geomorphological and paleogeographic research of Ukrainian Polissya pose today more questions about the formation and history of the relief and restoration of bygone environmental conditions. This applies to the various stages of its development, although the late Pleistocene – early Holocene is the most interesting and rather controversial one being a time of significant changes in nature and relief, recorded in a number of forms preserved on the earth's surface of this territory. The study of these surviving forms allows replicating the paleogeographic conditions of their formation, which is also a key to revealing the problems of contemporary climate changes on the Earth [3, 4].

From the perspective of aeolian processes, the formation of aeolian forms of the late Pleistocene is special because the dunes older than 30 thousand years have still been not found on the territory of Europe, as well as in Ukrainian Polissya. We will try to explain this fact by several statements: 1) these forms exist on this territory, but so far they have not yet been found; 2) older dunes have been destroyed and transformed and therefore are not now expressed through relief; 3) special conditions were formed in the late Pleistocene, which were crucial for the emergence and formation of aeolian forms. Due to the replication of paleogeographic conditions, it is known that in the history of nature since the degradation of the Dnieper glaciation in Ukraine and Polissya in particular, subaerial cryolithozones have repeatedly existed [1, 2, 8-10, 16, 19, 20 and oth]. However, aeolian forms were formed mainly on the verge of the late Pleistocene – early Holocene during the maximum development and degradation of the Valdai glaciation. It should be noted that V. Pazynych [11–15] generally objects to the aeolian genesis of sand molds of Ukrainian Polissya and Europe, considering them as parapets formed by the vortex activity of water flows at the bottom of the late Pleistocene lake [11-14 and oth].

The purpose of this article is to identify possible places of the restructuring of the

hydrographic network at the end of the Late Pleistocene – early Holocene based on the study of the distribution of relic dunes.

The main research methods were general geographic methods, including mapping, decoding of space images and GIS using software ArcGIS. They helped to establish the patterns of the distribution of dunes in right-bank Ukrainian Polissya and to identify the signs of the hydrographic network restructuring.

Results and discussion. The late Pleistocene morpholithogenesis is characterized by the extensive development of aeolian processes and the formation of dunes. As known, this is one of the most common forms of right-bank Ukrainian Polissya [4, 7]. Dunes were moving forms, and generally they were moving from the west or northwest to the east, which is evidenced by their orientation, morphology, location, and the texture of the deposits of which they are composed. However, on the territory of Polissya there are many so-called aeolian forms of “forced” accumulation. These are the dunes, the movement of which was suspended by certain barriers that existed at the time of active development and formation of aeolian processes. Swamped, or rather flooded areas were the major obstacles. While migrating, the dunes combined and concentrated along the boundaries of these areas.

The analysis of the distribution of dunes in right-bank Ukrainian Polissya allowed us to establish some patterns of their distribution, in particular, their concentration along certain lines. In the present relief of the study area, such concentration of aeolian forms is observed at the interface of the Upper Pleistocene terrace and the floodplain.

As known, there existed long frost (underground glaciation) on the territory of Polissya during the formation of dunes, which led to the emergence of the subaerial Cryolithozone with a particular type and expression of exogenous processes, including the development of aeolian and solifluctional processes, and the formation of ice and ice-soil cores [1, 3, 5, 8-10, 20 and others]. In subaerial cryozones, the functioning

of river systems was significantly different, marked by the presence of ancient permafrost and drastic seasonal climate changes. At the beginning of the warm period, when the snow was melting and an active layer was being formed, the water quickly flowed along the permafrost surface to river beds, causing the significant rise of water levels and, consequently, the accumulation of material on the late Pleistocene floodplains. When it started drying out, the aeolian processes began to rapidly develop, which explains a significant accumulation of Upper Pleistocene terraces [3].

Such peculiarities of river systems are typical of rivers which did not experience the direct effects of the glacier since their basins were located within the subaerial cryozone. These rivers are the upper part of the Pripyat and its right-bank tributaries, including the Goryn, Sluch, Stokhid, Uzh and others. Such functioning was facilitated by the plainness of right-bank Ukrainian Polissya.

The functioning of the rivers with the basins exposed to Valdai glaciation, including left-bank tributaries of the Pripyat and its middle and lower parts, was significantly different. In the late Valdai period during the glacier degradation, extreme floods were formed which are now expressed through the sizes of the late Pleistocene meanders [17, 18]. They are

common, for example, in the river valleys of Belarus or left-bank Ukrainian Polissya.

When analyzing the distribution of aeolian forms in the study area, it is important to consider not only the location of the dunes and their morphology, but also their interlocation. In order to emphasize this, we will further use the term "spatial and positional location of the dunes".

Complex combination and concentration of the dunes was found at the bottom of the Styr valley. Spatial and positional distribution of relic dunes from the west (from the villages of Konyk and Pryvitivka, Zarichnenskyi district) to the east (to the river Stubla floodplain; outskirts of the villages Olexandrove, Zarichnenskyi district, and Zelen, Dubrovyskyi district) is changing according to the typical pattern: parabolic dunes → double dunes → complex dunes (Fig. 1). Such location of the dunes makes it clear that the current channel and floodplain of the Styr river did not obstruct the movement of parabolic dunes as there is no forced transformation of the morphology of parabolic dunes and their conjunction with the rear seam of the floodplain, in the west of the square under study. However, a significant concentration of complex aeolian forms in the east of the square is characteristic of the rear seam lines of the floodplain of the right-bank Stubla.

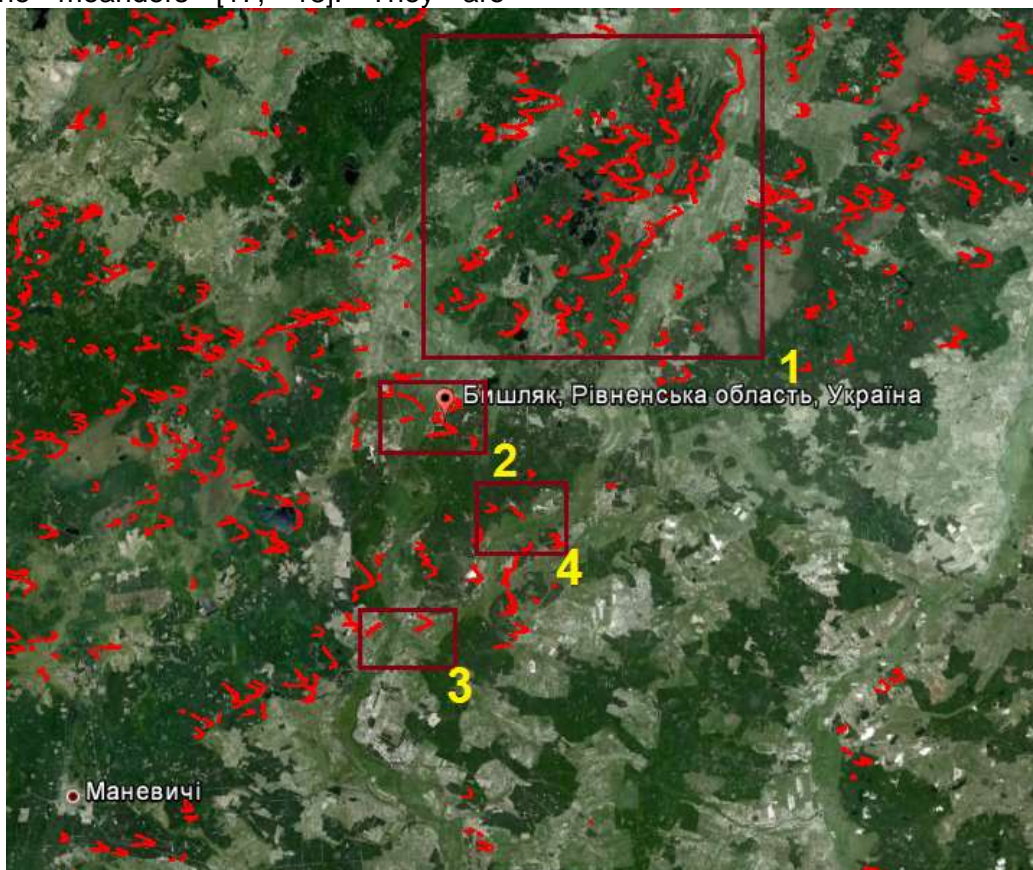


Fig. 1 – Distribution of relic dunes in the basins of the Styr and Stubla north of the town of Kuznetsovsk (the dunes are in red; Google Earth)

The analysis of satellite images of the area revealed the presence of a number of parabolic dunes in the Styr valley; they have been “cut” and partially destroyed by the river’s meandering channel (Fig. 2). The plots of these old dunes are distinguished in the midst of the floodplain, which proves that the channel of the Styr and its floodplain are younger compared with ancient dunes (this is also indicated by the absence of its Upper Pleistocene terrace). A detailed study of satellite images showed that in the past the Styr’s channel in the outskirts of the village of Sobishchytsi, Volodymyrets’kyi district, Rivne region, turned sharply to the east and, crossing the modern watershed, flowed along the Stubla valley (Fig. 3), forming large meanders (Fig. 4). Today the Stubla river valley is much wider than the current channel, indicating greater water content during its formation. In our opinion, the lower part of the Styr (to the south of the village of Sobishchytsi) did not exist in the late Pleistocene, or it was a small river and did not impede the movement of parabolic dunes. Only later, after the formation of relic dunes (probably, at the end of the late Pleistocene – early Holocene) the current channel of the river Styr was formed.

The signs of the old meandering channel are found in the east – south-eastern outskirts of the village of Vychivka, Zarichnenskyi district (Fig. 5). To the south – southwest of the village, the present Stubla channel turns to the northwest and eventually empties into the Styr.

The old meanders point to continuation of the Styr’s protochannel to the north (Fig. 5). The old channel of the river is also well decoded in Belarus – up to the point of its confluence into the Pripjat river. In particular, the old meanders of the proto-Styr are well identified in the image around the villages of Trushevo, Zholkino, Nechatovo and others on the territory of Republic of Belarus.

To the east of the old riverbed, we detect a system of wetlands, “contoured” by relic dunes. The detailed decoding of the satellite images of these areas allowed us to identify the places where they formerly connected with the old bed of the Styr. After the restructuring of the hydrographic network, including the formation of the present Styr channel and interception at the bottom of the Stubla, the hydrological system of the runoff significantly changed that was one of the major (apart from climate change) causes of the waterlogging of these areas.

The restructuring of the Styr’s channel was noted by O. M. Marynych [7]. According to this researcher, the main reason for its change was the existence and extinction of the Styr-Slovechna protovalley formed in time of the degradation of the Dnieper glaciation [7]. From the above we can assume that the Styr-Slovechna protovalley had existed before the time of the active development of aeolian processes and formation of dunes at the end of the late Pleistocene – early Holocene.



Fig. 2 – Styr river valley. Cutting of relict dunes by the meandering river channel (section 2 in Fig. 1; Google Earth, yellow arrows indicate the remains of part of a parabolic dune)

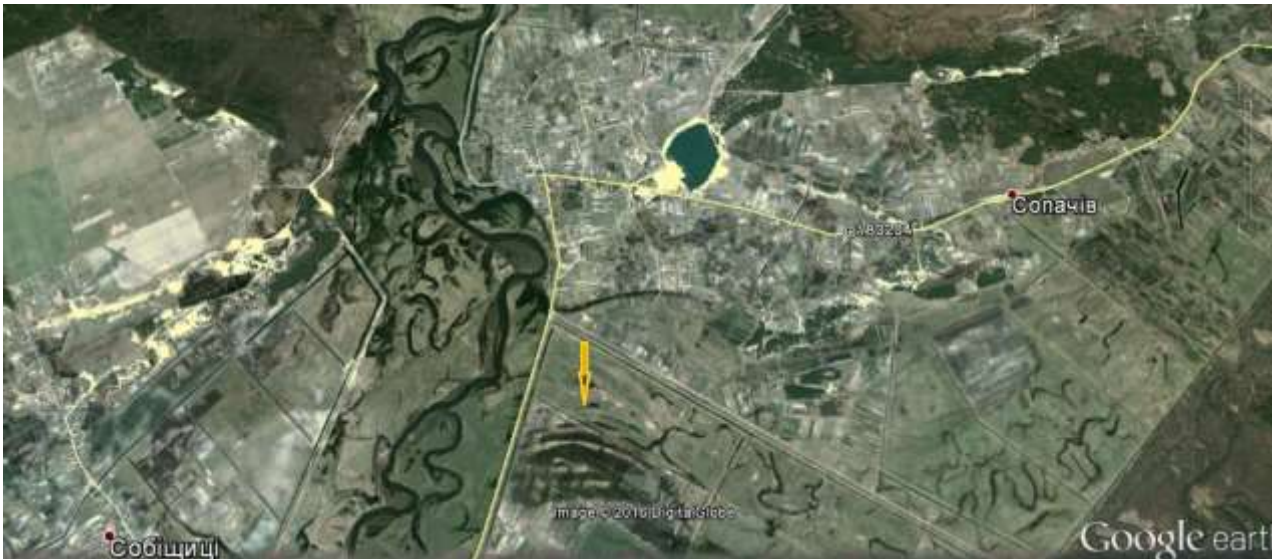


Fig. 3 – Watershed district of the Styr and Stubla

(section 3, Fig. 1; Google Earth; a yellow arrow marks the watershed area that formerly functioned as part of the Styr protovalley)

In right bank Ukrainian Polissya, several areas were identified where ancient dunes form a system stretched along a certain line of dunes. In particular, an almost straight series of the dunes stretching from the southwest to the northeast was found along the Veselukha valley, south-southwest of Velyke lake. Now they “contour” the wetlands. However, no distinct signs of old channels were found on the satellite images.

The signs of the ancient riverbed are also decoded near Velyke lake to the east, southeast

and northeast of the village of Novosillia and to the east of Loknytsya village, Zarichnenskyi district. It was first identified by V.G. Pazynych [12, 14], who considered it to be a valley of subglacial runoff. This old valley has been inherited by a small river Mill – a right tributary of the Veselukha river that now flows into the Pripyat east of lake Nobel. To the east of the village of Radove, Zarichnenskyi district, the canalized channel of the Veselukha river crosses the dune field without forming a coherent valley.

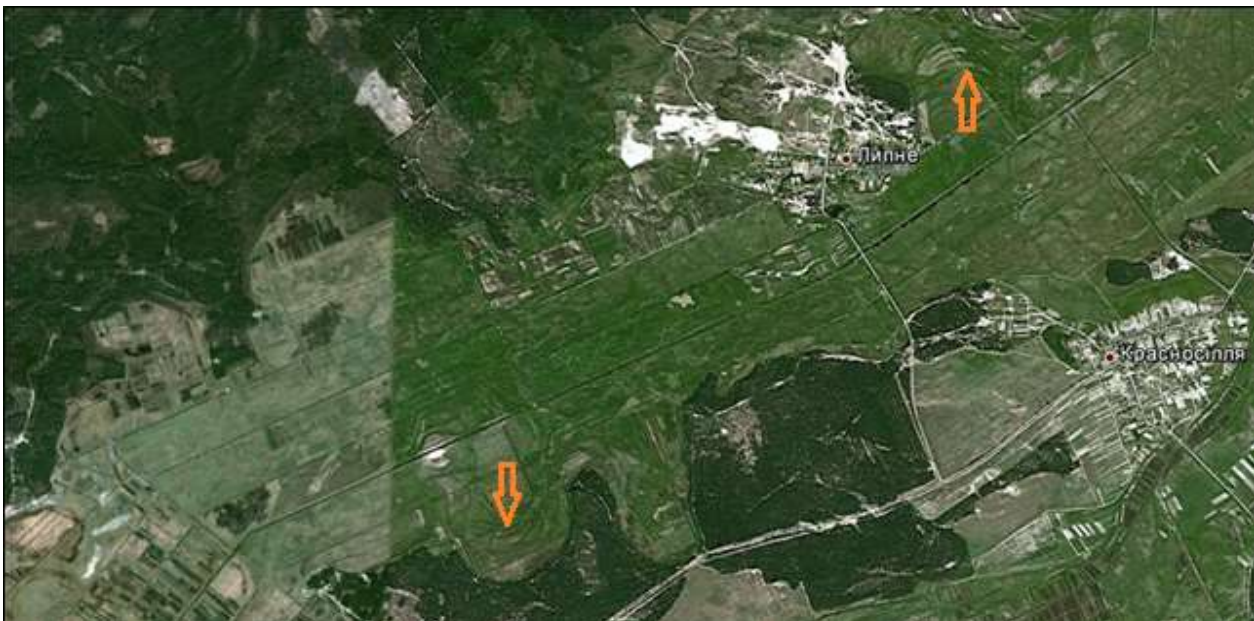


Fig. 4 – Old meanders (section 4, fig. 1; Google Earth)

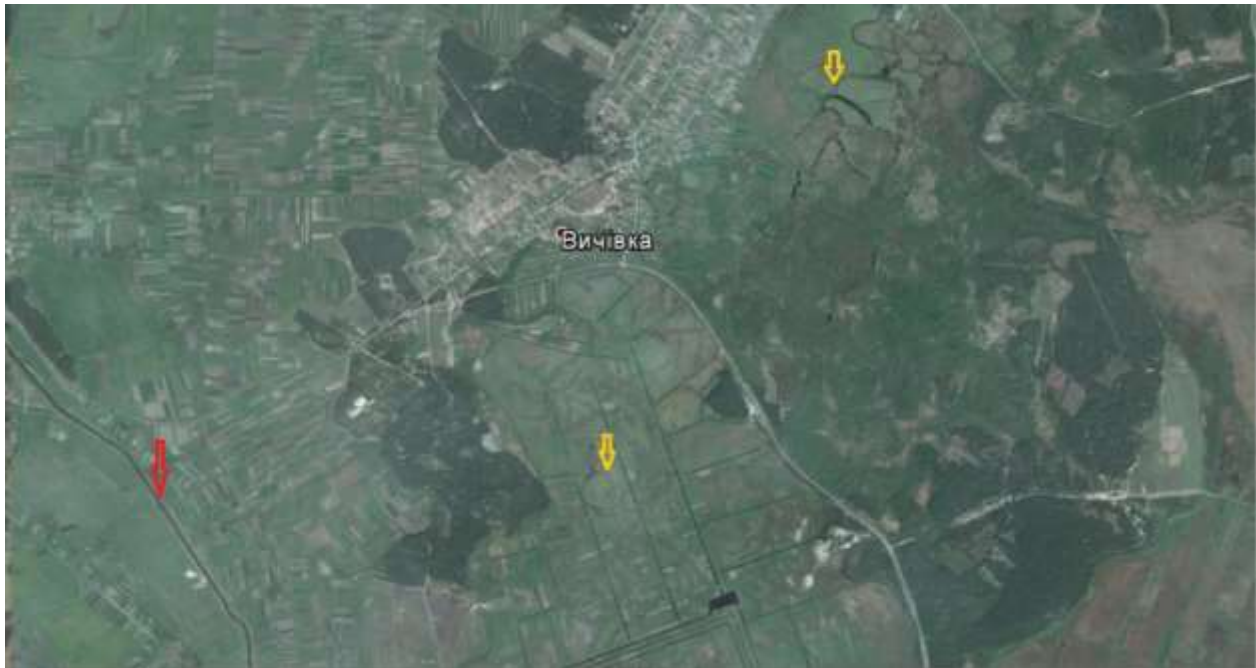


Fig. 5 – Signs of old meandering at the bottom of the Stubla valley (a red arrow indicates the present channel of the Stubla; yellow – signs of old meandering; Google Earth)

A number of “recessed” dunes, identified on the territory of the watershed of the Lva and Stryha rivers and late Pleistocene dunes, which are spread on the now swampy floodplain, indicate the change of climatic conditions and of the runoff hydrographic system. In particular, the results of thermoluminescent dating of dune deposits, located east of lake Nobel, showed its late Pleistocene age [6]. Thus, the swamping of the area occurred after the formation of aeolian forms.

Conclusions. The spatial and positional distribution of relic dunes made it possible to detect the existence of fluvial systems different from modern sites in the late Pleistocene, which

later, after the formation of relic dunes (probably in the early Holocene) underwent significant changes and acquired the present form. The changes of the flow of river water and climate (such as increased precipitation), were, in our opinion, the main cause of the waterlogging of large areas of right bank Ukrainian Polissya. To confirm or refute the above data on the restructuring of the hydrographic system of these areas immediately after the main phase of dune formation (at the end of the Late Pleistocene), it is necessary to perform geological and geomorphological profiling of the valleys with the signs of ancient riverbeds.

Literature

1. Bohutskiy A. B. Paleokriohennyye protsessy na zapade Ukrainy v verkhnem i srednem pleystotsene / Bohutskiy A. B., Velychko A. A., Nechaev V. P. // Problemy regional'noy i obshchey paleoehografii lessovykh i perihlyatsial'nykh oblastey. – M. : Nauka, 1975. – S. 80–90.
2. Herasymenko N. P. Etapnist' evolyutsiyi pryrodnoho seredovyshcha Ukrayiny u pizn'omu pleystotseni / N. P. Herasymenko, Zh. M. Matviyishyna // Fiz. geohrafiya ta geomorfolohiya. – 2007. – Vyp. 53. – S. 13–26.
3. Dubis L. Paleoehorafichni umovy rozvytku eolovykh protsesiv ta utvorennya dyun pravoberezhnoyi chastyny Ukrayins'koho Polissya naprykintsi pizn'oho pleystotsenu / L. Dubis // Geohrafiya i suchasnist'. Seriya 4. – 2012. – Vyp. 15(27). – S. 39–52.
4. Dubis L. F. Eolovyy paleomorfohenez pravoberezhnoyi chastyny Ukrayins'koho Polissya : dys... d-ra heohr. nauk : 11.00.04 / Dubis Lidiya Frantsivna. – K., 2013. – 497 s.
5. Dubis L. F. Fazy intensyvnoho rozvytku eolovykh protsesiv i dyunoutvorennya pravoberezhnoyi chastyny Ukrayins'koho Polissya / L. Dubis // Nauk. visnyk Chernivets'koho nats. un-tu. – 2012. – Vyp. 612-613 : Heohrafiya. – S. 40–45.
6. Dubis L. F. Litolohichni osoblyvosti vidkladiv ta vik reliktovoi dyuny poblyzu ozera Nobel / L. F. Dubis // Fiz. geohrafiya ta geomorfolohiya. – 2011. – Vyp. 1(62). – S. 104–110.
7. Marynych A. M. Geomorfolohiya Yuzhnoho Poles'ya / A. M. Marynych. – K. : Kiyev. un-t, 1963. – 252 s.
8. Nechaev V. P. Klimaticheskiye usloviya kriolitozony pozdnelednikov'ya na yuho-zapade Russkoy ravniny / V. P. Nechaev // Paleoklimaty holotsena Yevropeyskoy territorii SSSR. – M. : In-t heohrafii AN SSSR, 1988. – S. 116–124.
9. Nechaev V. P. Paleokriohennyye protsessy na territorii Volyno-Podol'skoy vozvyshenosti v verkhnem pleystotsene : avtoref. diss. ... kand. heohr. nauk : 11.00.04 / Nechaev V. P. – M., 1983. – 24 s.
10. Nechaev V. P. Paleokriohennyye protsessy na territorii Volyno-Podol'skoy vozvyshenosti v verkhnem pleystotsene : diss. ... kand. heohr. nauk : 11.00.04 / Nechaev V. P. – M., 1983. – 237s.
11. Pazynych V. L'odovykovi vodyani mlyny (Moulins) vnutrishnya l'odovykova ta pid'odovykova drenazhni systemy) – peretryannya tverdykh hirs'kykh,

porid pol'odovkovykh ozera (Kettle Lakes) / V. Pazynych. Rezhym dostupu: http://geografica.net.ua/publ/sattti/statti_ukrajinskikh_naukovciv/pazinich_v_lodovikovy_vodjani_mlini_moulins/82-1-0-1128 **12.** Pazynych V. H. Proverka sootvet-stviya nekotorykh landshaftno-heomorfolohicheskikh doktrin zakonam elementarnoy fiziki. Ch. 3. Proiskhozhdeniye Poles'skikh ozer i parabolicheskikh dyun / V. Pazynych // Heohrafika. – 2012. – http://geografica.net.ua/publ/sattti/statti_ukrajinskikh_naukovciv/pazinich_v_pokhodzhennja_poliskikh_ozera_t_a_parabolicheskikh_dyun/82-1-0-1095. **13.** Pazynych V. H. Rol' orohrafii tsentral'noy Evropy v stanovlenii poslednikovykh landshaftov Poles'ya / V. H. Pazynych // Fiz. geohrafiya ta geomorfolohiya. – 2011. – Vyp. 2 (63). – S. 197–200. **14.** Pazynych V. H. TOP-5 heomorfolohichnykh ta paleoheohrafichnykh problem Ukrayiny / V. H. Pazynych // [za red. V. Stetsyuka]. – K. : Vik-prynt, 2012. – 114 s. **15.** Pazynych V. H. Tukulany – fizicheskiye printsypy formirovaniya vo vremya dehradatsii lednikov [elektronnyy resurs] / V. H. Pazynych. Rezhym dostupa: <http://www.academia.edu/17161933>; **16.** Paleoklimaty i paleolandshafty vnetropicheskoho prostranstva Severnogo polushariya. Pozdnyy pleystotsen – holotsen: atlas-monohrafiya / [pod red. A. A. Velychko]. – M. : HEOS, 2009. – 120 s. **17.** Panin A. V. Makroizluchiny («bol'shye meandry»): problemy proiskhozhdeniya i interpretatsii / A. V. Panin, A. Yu. Sidorchuk // Vestnik MHU. Seriya 5 : Heohrafiya. – 2006. – № 6. – S. 14–22. **18.** Panin A. V. Flyuvial'nyye protsessy i rechnoy stok na Russkoy ravnine v kontse poznevaldayskoy epokhi / Panin A. V., Sidorchuk A. Yu., Borisova O. K. // Horizonty heohrafii : k stoletiyu K. K. Markova. – M. : MHU, 2005. – S. 114–128. **19.** Prostorovo-chasova korelyatsiya paleoheohrafichnykh umov chetvertynnoho periodu Ukrayiny / [za red. Zh. M. Matviyishynoyi]. – K. : Nauk. dumka, 2010. – 191 s. **20.** Spasskaya I. I. Ekzohennyy morfohenez / I. I. Spasskaya // Paleoklimaty i paleolandshafty vnetropicheskoho prostranstva Severnogo polushar'ya. Pozdnyy pleystotsen-holotsen: atlas-monohrafiya / [pod. red. A. A. Velychko]. – M. : HEOS, 2009. – S. 64–69.

Дубіс Л. Дюни як індикатори перебудови гідрографічної мережі правобережної частини Українського Полісся наприкінці пізнього плейстоцену – на початку голоцену. Обґрунтовано роль пізньоплейстоценових дюн як ідентифікаторів перебудови гідрографічної мережі. Проаналізовано причини формування «вимушених» форм еолової акумуляції, просторовий розподіл яких є підставою для виокремлення певних території, що у минулому перешкоджали руху дюн. На підставі просторового аналізу пізньоплейстоценових дюн правобережної частини Українського Полісся встановлено території, де наприкінці пізнього плейстоцену – початку голоцену, ймовірно, відбулася перебудова гідрографічної мережі. Значну увагу зосереджено на зміні гідрографічної мережі р. Стир, зокрема, відображено докази перебудови головного русла Стирі вже після формування й утворення дюн. Аналіз особливостей поширення дюн дав змогу висунути гіпотезу про значну перебудову гідрографічної мережі правобережної частини Українського Полісся саме після завершення головних фаз формування еолових форм. Методами дослідження слугували картографічні, дешифрування аерокосмічних знімків із застосуванням ГІС технологій.

Ключові слова: пізньоплейстоценові дюни, перебудова гідрографічної мережі, річка Стир.

Dubis L. Dunes as indicators of the restructuring of hydrographic network of right-bank Ukrainian Polissya in the late Pleistocene and early Holocene. The role of the late Pleistocene dunes as identifiers of the restructuring of the hydrographic network has been shown. The reasons for the formation of the “forced” forms of aeolian accumulation, the spatial distribution of which is viewed as the basis for singling out specific areas that interfered with the movement of dunes in the past, are analyzed. Based on the spatial analysis of the late Pleistocene dunes of right-bank Ukrainian Polissya, the areas have been identified where during the late Pleistocene – early Holocene the restructuring of the hydrographic network probably took place. Special attention is paid to the restructuring of the river Styr's hydrographic network. The evidence of the restructuring of the river's main channel after the dune formation phase is demonstrated. Proceeding from the analysis of the signs of dune expansion, a hypothesis on the significant restructuring of the hydrographic network of right-bank Ukrainian Polissya after the main phases of the formation of aeolian forms, has been put forward. The main research methods used were mapping and decoding of space images using GIS technology.

Keywords: late Pleistocene dunes, restructuring of hydrographic network, the Styr river.

Дубис Л. Дюны как индикаторы перестройки гидрографической сети Правобережной части Украинского Полесья в конце позднего плейстоцена – начале голоцена. Обоснована роль познеплейстоценовых дюн как идентификаторов перестройки гидрографической сети. Проанализированы причины формирования «вынужденных» форм эолового аккумуляции, пространственное распределение которых является основанием для установления территорий, которые в прошлом препятствовали движению дюн. Значительное внимание уделяется изменению гидрографической сети р. Стырь, в частности, отражено доказательства перестройки главного русла Стыря уже после формирования и образования дюн. Анализ особенностей распространения дюн позволил выдвинуть гипотезу о значительной перестройке гидрографической сети правобережной части Украинского Полесья после завершения главных фаз формирования эоловых форм. Методами исследования послужили картографические, дешифрование аэрокосмических снимков с применением ГИС технологий.

Ключевые слова: познеплейстоценовые дюны, перестройка гидрографической сети, река Стырь.