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PALEOENVIRONMENT. THE STONE AGE

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A CHRONOSTRATIGRAPHIC BASIS FOR GENERAL AND REGIONAL SUBDIVISIONS OF THE EURASIAN UPPER PALEOLITHIC

Cultural, historical and economic interpretation and reconstruction of the Upper Paleolithic hinge upon a more or less detailed chronological classification that must correlate with major global climatic events and, as far as possible, with regional environmental changes, including sea level fluctuations and the corresponding over deepening of coastal valleys in the Late Pleistocene.

Regional geochronological schemes

Of all the wealth and diversity of general and regional chronostratigraphic schemes based on different principles and data, the detailed evolutionary scheme of loess-soil formation in Eastern Europe, elaborated by M.F. Veklich primarily on the basis of the Ukraine Steppe geological sections, is considered to be the most fundamental and authoritative. Based on this scheme, litho-stratigraphic, geological and palynological studies were carried out at a series of sites in the steppe zone; they were conducted either by M.F. Veklich himself or with his participation. Many geological sections, discovered and excavated in the 1920s and 1940s (mostly on the Dnepr River upstream from the rapids), were described by Veklich's predecessors – V.I. Krokos, L.A. Lepikash, V.V. Riznichenko, and other Ukrainian geologists.

In the 1970s – 1980s, the Veklich scheme, expanded upon by leading Ukrainian geologists, pedologists and palynologists (Veklich et al., 1984), became standard for engineering-geological surveying in the Ukraine. Over the last three decades this scheme has been successfully applied to Paleolithic studies (Krotova, 1988, 1994; Anisyutkin, 1994; Dvoryaninov, Sapozhnikov, 2002; Kolesnik, 2003; Sapozhnikov, 2002a, b; 2003a, b; etc.).

Proceeding from dates obtained for the European early Upper Paleolithic, the three youngest horizons in the scheme are of primary interest for us: Bugsky (ca 50 – 30 ka BP)* or rather its upper portion, Dofinovsky (ca 30 – 32 to 22 ka BP) and Prichernomorsky (Black Sea) (ca 22 – 10 ka BP). The first horizon is subdivided into two sub-horizons; each of the other two is subdivided into three sub-horizons (Veklich, 1982: 49, 189 – 191, table 5).

The Upper Bugsky sub-horizon is represented by loess that accumulated during the Middle Würm (W_{II}); the Lower sub-horizon aside from the loess contains up to three incipient soils 0.1 – 0.2 m thick. In Eastern Europe, the thickness of the Bugsky sediments reaches 6 – 8 m with the mean of 4 – 5 m. The Dofinovsky horizon is represented by a thick buried soil or soils formed under warm climatic conditions. Middle (df_b) and Upper (df_c) Dofinovsky soils are the most distinct in the region under consideration; their thickness totals 1.5 – 2.0 m. The former are reddish-brown, falling into the type of southern chernozems solonetz-like soils; the latter bear features of brown semi-desert soils. The lithological structure of the Prichernomorsky horizon is more complicated. Overall, it was formed during the last glacial advance (W_{III}), while the earliest sub-horizon ($pč_1$), composed of loess, corresponds to the coldest environmental conditions of the middle Upper Paleolithic. The Middle sub-horizon ($pč_2$) consists of one or two light brown soils of the semi-desert type;

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* Only "uncalibrated" absolute dates are used in this paper.

the Upper sub-horizon (pč$_3$) is again composed of loess. The total thickness of the Prichernomorsky deposits in the southern Ukraine varies from 0.3 to 3.5 m, though it only rarely exceeds 2.5 – 3.0 m. The Upper Prichernomorsky sub-horizon (pč$_3$) has been influenced by Holocene soil formation processes and is less distinct. It is either absent from some sections or just 0.3 – 0.5 m thick. The maximum loess thickness of this sub-horizon recorded in key stratigraphic sequences is 0.8 – 1.1 m. The Middle Prichernomorsky soil (pč$_2$) is of the same or lesser thickness. Loesses (pč$_1$) are normally only slightly thicker, especially if the all three Prichernomorsky sub-horizons are present in the profile (Veklich, 1968; Veklich et al., 1977; Veklich, Sirenko, 1976).

The Veklich scheme was supplemented by data obtained by Gerasimenko, who, based on lithological and palynological studies of some stratigraphic sequences of the Donets Basin (including Upper Paleolithic sites of the Rogalik-Peredelskoye region), recorded two thin soil formations in the upper humified portion of the Upper Prichernomorsky sub-horizon. She correlated these formations with the warm Bölling and Alleröd periods of the Blitt–Sernander scheme (Veklich, 1987: 151 – 152, fig. 56). Accordingly, Gerasimenko (1997: 13 – 20, fig. 3 – 6, 8) also described Dryas Ic, II and III sediments. Quite recently, based on that study, traces of Alleröd pedogenesis have been recorded in the profile of the three-layered Terminal Paleolithic site of Mikhailovka (Belolesie) in the Dniester – Danube interfluve (Sapozhnikov, 2004). These inferences are *per se* based on the last works of Veklich, who also elaborated the detailed scheme of paleoclimatic stages for the Holocene and the Late Glacial (starting from the early Bölling). Veklich regarded the whole time span from 13.3 ka BP to the early Holocene (ca 10.3 ka BP) as a single period (nanoclimatochron II – h$_{al}$), which in the Blitt–Sernander scheme is subdivided into four stages: Bölling (Bl – h$_{al-1}$), Dryas II (Dr-II – h$_{al-2}$), Alleröd (Al – h$_{al-3}$) and Dryas III (Dr-III – h$_{al-4}$). It should be noted, however, that, unlike Gerasimenko, Veklich (1987: 149 – 165, fig. 61) did not identify a single stratotype which could correspond either to the Late Glacial *in toto*, or to at least one of the aforementioned individual stages.

Several other schemes, especially those based on materials from the East European Plain, generally (if one sets aside the problem of stage chronology) correlate well with the Veklich scheme. Thus, Moskvitin subdivided the Valdai Glacial phase into three stages: early, Kalinin Glacial (70 – 50 ka BP) with a series of phases and interstadials; middle, Mologo-Sheksna Interstadial (50 – 24 ka BP) with three climatic optimums; and late, Ostashkovo Glacial (24 – 10 ka BP). The last stage is divisible into glacial (consisting of two phases, Ostashkovo and Valdai, separated by the Mazursky Interstadial) and post-glacial (consisting of the Finn and Pomor phases) periods (Moskvitin, 1967; etc.). Largely due to the fact that this model was utilized to describe the stratigraphy of Upper Paleolithic sites in the Kostenki-Borshchevo region (Grischenko, 1976), until recently the scheme was very popular among scholars representing the "Leningrad School" of Paleolithic studies. A slightly simplified and modified variant of the scheme was used in the monograph entitled *The Paleolithic of the USSR* (Praslov, 1984; Rogachev, Anikovich, 1984; etc.).

The Veklich scheme can be correlated to some degree with other schemes showing relationships among Late Pleistocene stages and Upper Paleolithic events (Velichko, 1982, 1989; Velichko, Morozova, 1982; Velichko et al., 1997, 1999; Chebotareva, Makarycheva, 1982; Arslanov, 1975, 1992*; Nikiforova, Kind, Krasnov, 1984; Nikiforova, Ivanova, Kind, 1987; Zarrina, Krasnov, 1977; Zarrina, Krasnov, Spiridonova, 1980; Chichagova, 1972; Faustova, 1994; etc.).

It is relevant here to mention a scheme composed by the French researcher Djindjian. This scheme was elaborated on the basis of an extensive set of data obtained in Western Europe and numerous absolute dates for archaeological sites (Djindjian, 2002a, b; Djindjian, Kozlowski, Otte, 1999: 39 – 47). Lately this scheme has been widely accepted by scholars. In addition, the author has included several Upper Paleolithic sites of Central and Eastern Europe into it. Here it will be discussed in more detail. Environmental changes occurring during a span of 45 – 11 ka BP were subdivided into six periods: (1) warm Inter-Würm Pleni-interstadial (45.0 –34.0 ka BP); (2) cooler (oscillation) Prepleniglacial (34.0 – 28.0 ka BP); (3) Early Upper Pleniglacial (28.0 – 22.0 ka BP); (4) Glacial Maximum (22.0 – 16.5 ka BP); (5) Late Upper Pleniglacial (16.4 – 13.5 ka BP); and (6) Late Glacial (Tardiglacial, 13.5 – 11.0 ka BP). Short warm phases stand out against this background: Moershofd (ca 43 – 41 ka BP), Hengelo (ca 39 ka BP), Les Cottes (ca 34 – 35 ka BP); as well as better known and more accurately dated Arcy (sub-period 2B; 32.0 – 30.0 ka BP), Maisieres (2D; 29.0 – 28.0 ka BP), Tursac (3B; 25.0 – 24.0 ka BP), Laugerie (4C; 20.0 – 19.0 ka BP), Lascaux (4E; 18.0 – 16.5 or 18.0 – 17.0 ka BP), Bölling (6A; 13.5 – 12.5 ka BP), and Alleröd (6C; 12.0 – 10.8 ka BP). These phases are separated by cooler episodes. It should be noted that in this scheme, Dryas I directly follows Lascaux and there are no other warm phases until Bölling.

As follows from the Table, the Djindjian scheme generally and specifically correlates with the Veklich scheme. Thus, phases 2B – 2D and the whole third period as an aggregate can be correlated with the Dofinovsky

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* These schemes have been recently analyzed by Krotova (2003).

horizon (or Paudorf, Donau Interstadial and others); the second (without Lascaux), with the Lower Prichernomorsky; Lascaux, with the Middle Prichernomorsky; and the fifth and the sixth, with the Upper Prichernomorsky. The warm phases (Arcy, Maisieres and Tursac) can be compared with the three soils (sub-horizons) of the Dofinovsky horizon, while Moershofd and Hengelo, with the three incipient soils of the Lower Bugsky sub-horizon.

Previously, Khotinsky wrote that facts force researchers to dismiss the idea of absolute synchronicity of climatic fluctuations (especially short-term ones) on a global scale (1977: 184). However, he also demonstratively proved that the phases of the Blitt–Sernander scheme could be traced all over Northern Eurasia, and Veklich (1987: 152 – 154, fig. 58) drew parallels between these phases and events in Siberia, the Far East, Japan, Canada, USA, and even in Columbia and Chile.

The aforementioned provides support for the inclusion of an extra warm phase – Raunis (Msta Interstadial; 14.5 – 13.0 ka BP) into the schemes of Veklich and Djindjian. Thus, a cold period between Lascaux and Raunis would correspond to the Vepsovo (South Lithuanian, Pomor, Pomeranian) Stade (15.5 – 14.5 ka BP) (Khotinsky, Deverits, Markova, 1966; Faustova, 1994; Lisitsin, 2000), which is called by some researchers Dryas Ib. Apropos the same designation is applied to the period separating the Glacial Maximum and the beginning of the Lascaux warming (Dansgaard et al., 1993; Djindjian, Kozlowski, Otte, 1999: fig. 2.3) absent in the Djindjian scheme.

Thus, in the Veklich scheme, based on thorough analysis of the Ukrainian loess-soil deposits, such warm phases as Les Cottes, Laugerie, and Raunis have not yet been recognized. It should be stressed that these phases are lithologically indistinct in the region under consideration. Laugerie and Raunis, however, are occasionally revealed by some other methods, for instance, by palynological analysis. Very likely, in the steppe zone of Eastern Europe, these environmental events were less tangible and/or short-term.

Taking into consideration the virtues and shortcomings of the above-described schemes and based on the available absolute dates, including those obtained for Upper Paleolithic sites of the Steppe Ukraine (to date, over 70 dates for 25 sites) (Sinitsyn et al., 1997; Krotova, 2003; Stepanchuk et al., 2004), the present author has constructed a basic correlation scheme which has not been previously published (see Table).

In recent years, Ukrainian geologists have developed a new scheme for loess-soil formation in the Ukraine. By this, we mean studies conducted by Gozhik and Shelkoplyas with co-authors and presented mostly in tabloid form. Essential differences present in their works indicate that the construction of the new scheme has not yet been completed. However, since some researchers involved in Paleolithic studies have already referred to it (Krotova, 2003), it is worthwhile to discuss it at least briefly.

Gozhik and Shelkoplyas suggested that two horizons should be singled out within the late Pleistocene: Bryansky (Vitachevsky), dating to ca 45 – 35 ka BP, and Bugsky (35 – 10 ka BP). The latter horizon comprises Bugsky, Dofinovsky and Prichernomorsky horizons of the Veklich scheme, though they are regarded as sub-horizons and no chronological frames are given for them (Shelkoplyas et al., 1986: 17, 34 – 36, table 4). According to other data, the buried soils (with loess interbeds) of Vitachevsky horizon date to 45 – 30 ka BP; the Bugsky loess, 27 – 17 ka BP (its thickness reaches 12 – 18 m); the Dofinovsky soil (or soils), 16.1 – 13.7 or 17.1 – 15.3 ka BP; and the Prichernomorsky loess, from 15.3 – 13.7 to 10.0 ka BP (Gozhik et al., 2000, 2001; Krotova, 2003: table 1).

Based on this scheme, one of the most complete Ukrainian loess sequences was described. This sequence is located near Roksolany village, on the left bank of the Dniester estuary, and comprises Quaternary sediments 48 – 51 m thick. Here, the Bugsky loess (ka 10 m thick) dates to 25.1 – 16.17 ka BP and the Dofinovsky soil correlated with Raunis warming, to 13.7 ka BP. These deposits are overlain by the Prichernomorsky loess which are 10.1 m thick and contain two buried soils (the upper one is dated at ca 10.0 and the lower one at 11.5 ka BP). In the other geological profile, located on the Black Sea shore between Kurortnoye and Primorskoye villages in the Dniester – Danube interfluve, the Bugsky loess 4.6 m thick dates to 26.1 – 21.3 ka BP; the Dofinovsky lower (of two recorded) soil, 16.3 ka BP, and the Prichernomorsky loess, 12.6 – 9.5 ka BP (Shelkoplyas et al., 1986: 93 – 95, fig. 11, 12).

It should be noted, however, that these "absolute dates" (generated by N.N. Kovalukh in the Kiev Radiocarbon Laboratory) do not match any of the above-mentioned geochronological schemes and are apparently younger than many leading experts believe (Nikiforova, Ivanova, Kind, 1987: 21). The obviously exaggerated thickness of the Prichernomorsky loess in the Roksolany profile, as well as some other dubious points, appear to discredit the described scheme.

Issues in the absolute dating of natural stages and events

Having established the principal climatic phases of the Upper Paleolithic, we will address their absolute dating. This can only be considered in the most general terms since the number of dates cited in various schemes is

Correlation of geochronological sequences with the general scheme of the Upper Paleolithic periods*

Veklich scheme				Djindjian scheme			General scheme		
ka BP	Horizon	Sub-horizon	Deposits and events	Periods	Sub-periods	Phases	Subdivisions	Level	Events and phases
10.3	Prichernomorsky (pč)								
			Late Glacial Al, Dr-III, Dr-II, Bl	6	AD	Dr-II, Al Bl	Late	Upper	Dr-III Dr-II, Al Bl
		pč$_3$							
			Loess						Dr-Ic
15				5		No phases Dr-I		Middle	Raunis
									Dr-Ib
		pč$_2$	Soil (Lascaux)						
								Lower	Lascaux
					4E	Lascaux			
							Middle	Upper	Dr-Ia
					4D	Maximum			Maximum
				4				Middle	
20		pč$_1$	Loess		4C	Laugerie			Laugerie
					4B	Maximum			
								Lower	Early Glacial
					4A				
					3C		Early		
		df$_c$	Soil					Upper	
25					3B	Tursac			Tursac
	Dofinovsky (df)			3					
		df$_b$	Soil		3A				
								Middle	
					2D	Maisieres			Maisieres
					2C		Initial		
30		df$_a$	Soil						
								Lower	
				2	2B	Arcy			Arcy
					2A				
	Portion of Bugsky (bg)					Les Cottes			Les Cottes
35		bg$_2$	Leoss						
				1	Non				
			Loess and soils						
40		bg$_1$				Hengelo			Hengelo

*Constructed according to (Veklich, 1982, 1987; Djindjian, 2002; Dansgaard et al., 1993; Sapozhnikov, 2003).

too large. However, one of the first integrative works, published by Kind 30 years ago (1974), has retained its importance. She collected and analyzed absolute dates from various parts of Eurasia and North America published by the early 1970s.

Dates cited by her indicate that stages correlating with the Dofinovsky horizon of the Veklich scheme (Lipovka-Novoselovo warming in Siberia, Farmadale Interstadial, Pampoint, etc. in the USA) fall within the 30.0 – 22.0 ka BP interval, and those correlating with the Lower Prichernomorsky horizon (Gydan stage of the Sartan Glacial, Ostashkovo Glacial, respective stages of Valdai and Vistula, shifts of the North American glaciers, etc.) fall within the 22 to 16.5 –16.0 ka BP, whereas the glacial maximum occurred at 20.0 – 18.0 ka BP. The following interstadial (Middle Prichernomorsky sub-horizon), registered in Eurasia and North America (Lascaux, Lake Erie, etc.), dates from 16.0 – 15.0 ka BP in Siberia and the USA, and from 16.5 – 15.5 ka BP in Western Europe. Dates of the late interstadials are as follows: Raunis (Susaka, Plussa, Karry-Port-Huron and others), from 13.7 – 13.6 to 13.2 ka BP; Bölling (Fieres and Kokorevo stages), from 13.0 – 12.8 to 12.0 ka BP; Alleröd (Taimyr warming), 11.8 – 11.4 ka BP (Ibid.: 227 – 228, table 17).

These dates show a close correspondence to those of the Late Pleistocene stages in the Veklich scheme. In some publications, however, the upper boundary of the Dofinovsky horizon, correlating with Stielfrid B, Bryansk soil, RK-I, Paudorf, Denekamp, etc. (Velichko, 1982: 67) is believed to be as early as 24 – 23 ka BP, and its lower boundary as early as 32 or even 33 ka BP (Zarrina, Krasnov, 1979; Velichko, Morozova, 1982: 118 – 119; Chebotareva, Makarycheva, 1982: 24, fig. 2; Ivanova, 1986: 166 – 167, etc.; Nikiforova, Ivanova, Kind, 1987: 20 – 21; Velichko et al., 1987: 25; etc.). Western researchers, based on Central European geochronology, often draw the upper limit of this horizon as early as 25 ka BP (Hoffecker, 1987; 1988: 242) or even 27 ka BP (Soffer, 1985: fig. 2.9), which is rather close to Danube–Bryansky warming in the Arslanov (1992) scheme (32.0 – 25.0 ka BP).

The date of the upper limit of the Lower Prichernomorsky horizon (Desna horizon, Valdai loess II, etc.), which, according to most writers, correlates with the beginning of the Lascaux Interstadial, is more problematic. Leroi-Gourhan herself, who established Lascaux in the early 1960s, dated it to ca 16.0 ka BP (Leroi-Gouran, Brezillon, 1965; Soffer, 1985: fig. 2.9). Some specialists, however, believe it to be earlier (18.0 – 16.0 ka BP (Burdukiewicz, 1987: 66 – 67) or 18.0 – 16.5 ka BP (Djindjian, 2002a: 26)) while others think it is later (16.0 – 15.5 (Dolukhanov, Pashkevich, 1977) or even 15.0 ka BP (Praslov, 1984: 4)). More recently, many Eastern European researchers have dated Lascaux (pč$_2$, Trubchev Interphasial) to 17 – 16 ka BP (Ivanova, 1986: 167; Nikiforova et al., 1987: 20; Velichko et al., 1987: 25, fig. 1; Pashkevich, 1984; etc.), and later Arslanov (1975: 25; 1992: 17) dated it to 16.5 – 15.0 ka BP. Clearly, the upper boundary of Lascaux coincides with the lower boundary of the Upper Prichernomorsky sub-horizon in the Veklich scheme (Altynov horizon, Valdai loess III, etc.).

Views are more uniform with regard to the Late Würm (Valdai) glacial maximum that occurred during the formation of the Lower Prichernomorsky sub-horizon. Dolukhanov (1972: 20) dates the peak of this event to 20 ka BP. Others prefer 20 – 18 ka BP (Kind, 1974: fig. 56; Ivanova, 1986: 167; Nikiforova, Ivanova, Kind, 1987: 20; etc.) or 20 – 17 ka BP (Zarrina, Krasnov, 1979: 37). According to one view, the deepest among the Late Pleistocens loesses, loess-II (Desna) formed ca 23 – 17 ka BP,* and the cooling itself had no peak (Velichko et al., 1987: 25; etc.). It should be noted that outside the periglacial zone, for instance in the Near East, the cooling and aridization phase began ca 36 ka BP, and its peak occurred between 22 and 18 ka BP (Dolukhanov, 1989: 80). Leading American climatologists, using integrated dates, estimate the Wisconsin glacial maximum at 22.0 – 14.0 ka BP, its peak at 18.0 ka BP, and the deglaciation period at 14.0 – 10.0 ka BP. In Antarctica, according to the American writers, initial deglaciation began 18.0 – 17.0 ka BP (Crowley, North, 1991: 47, 62). Paleobotanists have arrived at similar conclusions based on pollen analysis. For instance, Pashkevich (1984) dates the last glaciation to 25.0 – 17.0 ka BP, and its peak to 18 ka BP.

According to Djindjian (2002a: 25), the glacial maximum, at least in Western Europe, had two peaks separated by the Laugerie stage mentioned above. The first peak was dated to 21.0 – 20.0 ka BP, and the second one to 19.0 – 18.0 ka BP. This approach agrees with that taken by Moskvitin (1967), who established the Mazur Interstadial, as well as with the conclusions made by Spiridonova, who, based on the analysis of the pollen sequence from Muralovo in the Azov area, traced a warming stage in the middle of the Valdai deposits (23.5 – 17.0 ka BP) and dated it to ca 21.0 ka BP** (Spiridonova, 1991: 129, fig. 32).

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* In the 1910s and 1920s, Milankovich (1939: 155, 172 – 173, diagr. II–IV), based on a mathematical analysis of diachronic fluctuations of solar activity and changes in the ecliptics of the Earth, estimated the Würm III glacial maximum in the moderate latitudes of the northern hemisphere at 25 – 24 ka BP, which is close to calibrated dates.

** She evidently made a mistake when she called this phase "Tursac Interstadial" (clearly, this can only be Laugerie, see Table), and the entire maximum of Valdai glaciation "the Vepsovo stage", which is also erroneous.

Additional evidence for the dating of the glacial maximum is provided by the occurrence of dated sites on the Russian Plain, collected by Dolukhanov. His plot clearly reveals the virtual absence of sites with absolute dates from 19.0 to 18.0 ka BP. Strangely, Dolukhanov (2000: fig. 3.9, p. 79) ignores this fact when he dates the glaciation peak to 22 ka B P.

This might conclude our survey of problems involved in the absolute dating of Late Pleistocene horizons and sub-horizons and their analogues, but there exists one more group of radiocarbon dates concerned with global fluctuations of sea level in general and those of the Black Sea in particular during the Late Pleistocene. Kind (1974: 213, table 17) has integrated the available evidence and concluded that ca 35 – 30 ka BP, sea level was close to modern conditions. Subsequently it progressively fell, attaining its lowest point (–115 m or possibly –90 m) during the glacial maximum, 20 – 18 or 17 – 16 ka BP.

Later the oceanic regression was estimated at an even lower level (–125 to –130 m or even lower), and dated to 20 – 18 ka BP. However, the level of the Black Sea could not have dropped so low, because it was clearly delimited by the deepest places of the Bosphorus and the Dardanelles, which, according to specified data, could not have exceeded 90 – 110 m (Blagovolin et al., 1982: 11 – 12). Scherbakov (1982: 113 – 115; 1983: 19, 107, fig. 26) estimated the lowest level of the Black Sea at ca –90 m, and, using absolute dates, dated the foot of the Pontic Neo-Euxines (the borderline between the regression peak and the beginning of the transgression) to 18 – 17 ka BP. Serebryanny (1982: 161 – 163) suggested younger dates for the maximal regression (15.0 or even 14.0 ka BP), with which Fedorov (1982: 151) apparently agreed.

Shortly afterwards, an entire series of ^{14}C dates was published for samples of mollusk shells collected by Karpov from the bottom drill-holes in the external shelf of the Black Sea. The earliest of them provide dates for the bottom parts of the Neo-Euxinian deposits traced in the holes drilled at the depth of 90 – 100 m. Overall, they fall within the interval from 17.98 – 17.78 to 17.3 ka BP and correspond to the earliest rise of the sea level after its maximal regression (Gozhik et al., 1987: 27, table 7). These facts unambiguously disprove Serebryanny's view and suggest that the end of the glacial maximum must be dated to ca 18 ka BP. At the same time, the depths from which the samples were taken indicate that the lowest level of the Black Sea could not have been lower than –100 m.

Without dwelling upon the analysis of dates of late glacial and post-glacial events (these dates vary mostly with regard to minor details), we will cite the scheme recently used by Lisitsyn (2000; Faustova, 1994; etc.). Vepsovo stage, 15.5 – 14.5 ka BP (Dryas Ib, Southern Lithuanian, Pomor, etc.): subarctic climate; Raunis (Msta Interstadial), 14.5 – 13.0 ka BP; Old Dryas cooling, (Dryas Ic, Krestets stage, Haania, Middle Lithuanian), 13.0 – 12.8 ka BP; Bölling warming (Plussa Interstadial), 12.8 – 12.3 ka BP; Middle Dryas cooling (Dryas II, Luga and Neva stage, Northern Lithuanian, etc), 12.3 – 12.0 ka BP; Alleröd warming (interstadial), 12.0 – 11.0 ka BP; Young Dryas cooling (Dryas III), 11.0 – 10.3 ka BP.

Another stage, commonly mentioned to emphasize the specificity of the latest Upper Paleolithic sites, is the so-called Terminal Paleolithic. Its lower boundary is often correlated with the beginning of Dryas Ic, and sometimes with Late Bölling. However, according to Veklich (1987: 164, fig. 61), if the Late Glacial period should be viewed as a separate stage at all, then its lower border must correlate with the beginning of Bölling warming, so that Dryas II, Alleröd, and Dryas III fall within this period, especially because the former was quite short.

The facts and absolute dates cited above, then, suggest that the lower border of the Dofinovsky horizon (beginning of the early Upper Paleolithic – 30 or 32 ka BP* based on the date of the Arcy phase) must be specified. The same applies for the upper and lower borders of the Lower Prichernomorsky sub-horizon, and for the beginning of the glacial maximum (its end has been established with sufficient accuracy). One more aspect remains to be mentioned, the correlation of ^{14}C dates with true calendar ones, as the former require calibration (Stuiver, Kromer, Becker, 1986; etc.). At present, this calibration (based on samples of wood) is only possible for dates younger than 18.0 ka BP. It has been demonstrated that radiocarbon dates in the interval from 20 – 10 ka BP are younger than calendar dates by 800 – 1000 years on average, those within 30 – 20 ka BP by 1.5 ka years, and those within 35 – 29 ka BP are nearly identical to the calendar dates (Svezhentsev, 1997). According to Crowley and North (1991: 47), the difference between radiocarbon dates correlating with the last glacial (22 – 14 ka BP) and calendar dates can be as high as 3.5 ka in some regions.

At present, it is apparently too early to attempt a general calibration of radiocarbon dates for the Upper Paleolithic of Eurasia, if only because many of them result from biased approaches or are downright faulty (Sinitsyn, 1997). These include dates for Muralovka, Zolotovka I, Govorukha, Fedorovka, Novovladimirovka II, Voznesenka IV lower stratum, and Syuren I, many dates for Kamennaya Balka II, etc. (Sapozhnikov, 2003a: 230; 2003c; etc.), as well as Kovalyukh's dates for natural transects at Roksolan and Primorskoye cited above. In my view, revealing these or similar

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* Veklich himself (1982: 190) considered the latter date, 32 ka BP, possible.

discrepancies and errors is an urgent task, since without this, reliable working periodizations will be impossible even if an accurate chronostratigraphic succession is available.

Conclusions

Due to the reasons discussed here and others, mostly ecological and geographic related to zonality (Dmitriyev, Belokobylsky, 1989), the absolute dating of the principal horizons, sub-horizons, and phases in the classification schemes raises a number of problems that are far from being resolved. However, thanks to the work of many researchers, the general chronostratigraphic sequence of the Upper Paleolithic appears quite harmonious and logical (see Table). Proceeding from the above-given analysis of the absolute dates, the main stages of the Upper Paleolithic can be dated as follows:

Initial Upper Paleolithic (pre-Dofinovsky or pre-Bryansky Upper Paleolithic) terminated ca 32 ka BP;

Early Upper Paleolithic (= Dofinovsky horizon), 32 – 22 ka BP; three subdivisions can provisionally be singled out in it: lower (ca 32 – 29 ka BP), middle (ca 29 – 25 ka BP), and upper (ca 25 – 22 ka BP);

Middle Upper Paleolithic (= Lower Prichernomorsky sub-horizon), 22.0 – 16.5 ka BP; three subdivisions can be isolated within it: lower (ca 22 – 20 ka BP), middle (ca 20 –18 ka BP), and upper (= Dryas Ia) (ca 18.0 – 16.5 ka BP); Glacial Maximum (= maximum regression of the oceans) can be isolated as a separate event (19 – 18 ka BP), while no evidence of Laugerie (20 – 19 ka BP) has yet been recorded in the Ukraine;

Late Upper Paleolithic (= summarily Middle and Upper Prichernomorsky sub-horizons), 16.5 – 10.3 ka BP, includes lower (= Lascaux) (16.5 – 15.5 ka BP), middle (= Dryas Ib, Raunis, and Dryas Ic summarily) (15.5 – 13.0 ka BP), and upper (= Bölling, Dryas II, Alleröd, and Dryas III summarily; can be designated as Terminal Upper Paleolithic) (13.0 – 10.3 ka BP) (Sapozhnikov, 2002a, b; 2003a: 230; 2003c).

Importantly, the accuracy of currently available dates of principal stages, levels, phases, and separate events warrants the use of our classificatory scheme as a basis for a detailed subdivision, both general and regional. These key dates along with facts concerning stratigraphy, floral and faunal remains, and the morphology of stone tools can be used as benchmarks for a more reliable dating of specific sites and for the correction of erroneous dates.

The present scheme has already been used for the elaboration of a detailed chronological subdivision of the Upper Paleolithic in the steppe zone of the Ukraine (Sapozhnikov, 2003a: 230, 289; etc.). Evidently, however, it is also applicable outside this region since it is based on natural events many of which concern Eurasia in general and sometimes even the planet at large.

Facts discussed above favor the fourfold rather than the traditional threefold division of the Upper Paleolithic. Specifically, it is necessary to add a separate stage related to the initial (Pre-Bryansky) Upper Paleolithic (Gladkikh, 1991; Anikovich, 2000; etc.), which should be regarded as an "empty cell" so far devoid of any cultural content.

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