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# DENTAL REMAINS FROM THE MIDDLE PALEOLITHIC LAYERS OF ALTAI CAVE SITES*

*Two Middle Paleolithic cave sites in the Altai – Okladnikov and Chagyrskaya – have yielded dental remains (mostly isolated teeth) of individuals of various ages. A newly discovered mandibular fragment with teeth from Chagyrskaya Cave reveals a Neanderthal trait combination: anterior fossa and epicristid (midtrigonid crest) on molars, metaconid and crest on premolars. The totality of dental traits support the conclusion previously drawn on the basis of postcranial characters: Altai Neanderthals appear to be intermediate between other Eurasian Neanderthals and anatomically modern humans.*

Keywords: *Human evolution, Neanderthals, Mousterians, Gorny Altai, dental traits.*

## Introduction

Mousterian habitation horizons associated with Neanderthals were discovered in Okladnikov and Chagyrskaya caves in the piedmont zone of the northwestern Altai. Okladnikov Cave (formerly Sibiryachikha, named after a nearby village) was discovered in 1984 by A.P. Derevianko and V.I. Molodin. V.T. Petrin's excavations carried out in the same year revealed isolated human postcranial remains and several teeth representing individuals of various age in strata 2, 3, and 7.

Later, systematic excavations were conducted in Okladnikov Cave with the use of a variety of methods. The lithic industry discovered at the site differs from other industries of the Altai and Siberia by a predominance of butchering tools apparently used to process the carcasses of large animals. Evidently this was a Mousterian hunting and butchering camp site (Derevianko, Markin, 1992). Based on the results of uranium and radiocarbon analyses, all habitation horizons date to 45–40 ka BP (Derevianko, 2011).

A preliminary examination of hominin remains from Okladnikov Cave was conducted by V.P. Alexeyev, and the results were published posthumously, much later. Having compared these remains with others, Alexeyev noted the presence of distinctly archaic traits but refrained from attributing the finds to a specific geographic group (1998).

C.G. Turner II also examined the teeth from Okladnikov Cave. Having noted a number of

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Neanderthal apomorphies, he concluded that the inhabitants of this cave were closer to European than Asian Neanderthals (Turner, 1990).

The same dental remains were revisited by E.G. Shpakova, in whose view, they differ from contemporaneous remains from Denisova Cave in being less archaic. Shpakova concluded that in certain respects the teeth from Okladnikov Cave resemble those of European Upper Paleolithic humans (Shpakova, 2000, 2001; Shpakova, Derevianko, 2000). Neanderthal apomorphies which, according to Shpakova, are absent in the Okladnikov Cave sample include the epicristid (midtrigonid crest) on the lower molar and a relatively wide talonid (Shpakova, 2001: 71). Also, the crown dimensions of the preserved teeth are similar to those of Upper Paleolithic Europeans. Based on these observations, Shpakova concludes that the Okladnikov Cave hominins were anatomically modern humans (Shpakova, Derevianko, 2000; Shpakova, 2001).

Recently an examination of these remains was undertaken by B.T. Viola (2009). Like his predecessors, he noted that interpreting the observations was difficult. On the one hand, archaic (specifically Neanderthal) features are no doubt present. These include the wrinkled occlusal surface of the lower molar, complexity of furrows, a distinct anterior fossa, and a sixth cusp. On the other hand, the first molar lacks the epicristid (Zubov, 1992), or midtrigonid crest, which is a characteristically Neanderthal trait – 96 %, according to Bailey (2002). The third molar of another individual from the same cave exhibits an incomplete crest, indirectly suggesting that the epicristid was present. Based on the CT scanning and a 3D reconstruction of all permanent teeth from Okladnikov Cave, Viola demonstrated the presence of epicristid on the dentin surface. Referring to Bailey's summary (2001), Viola concludes that continuous midtrigonid crests on the occlusal surface are exceedingly rare in modern humans but very common in Neanderthals (2009: 133).

The excavators' views concerning the presence of Neanderthals in the Altai and less straightforward observations made by specialists in dental anthropology have been convincingly supported by the results of DNA sequencing. This study revealed distinctly Neanderthal genes in Okladnikov Cave hominins (Krause et al., 2007).

In the same year, S.V. Markin discovered Middle Paleolithic habitation horizons at another site – Chagyrskaya Cave. In 2008–2009, the lithics from that cave were shown to be similar to those from Okladnikov Cave (Derevianko, Markin, 2011). Like the Okladnikov assemblage, that of Chagyrskaya was described as Mousteroid (Derevianko, Markin, Zykin, 2009; Derevianko, Markin, 2012; Markin, Zykin, Zykina, 2011; Derevianko, Markin, 2011). These two cave sites strongly suggest that Neanderthals were present in the Altai.

Among the first dental remains from Chagyrskaya was a specimen that we identified as a lower deciduous canine crown (Buzhilova, 2011). While being relatively gracile, it resembles Neanderthal deciduous canines in shape. Dental and archaeological facts, then, jointly demonstrate that the Mousteroid tradition was introduced by the Neanderthal migrants to the Altai.

B.T. Viola, who studied two permanent teeth from Chagyrskaya, attributed them to Neanderthals, their poor preservation and heavy wear notwithstanding (Viola et al., 2011). Later, a preliminary analysis was published of a partial mandible with the right corpus and a canine, two premolars, $M_1$ and $M_2$ (Viola 2012). Despite a moderate abrasion, it was possible to detect anterior fossae and epicristids (midtrigonid crests) on both molars, and metaconids and crests on premolars – features typical of Neanderthals.

## Materials and methods

Thanks to ongoing excavations at Chagyrskaya, the number of dental remains increased markedly. In this study, dental remains discovered by S.V. Markin in 2008–2012 are examined and compared with those from other Middle and Upper Paleolithic sites in Eurasia.

The preservation of several deciduous and permanent teeth from the Sibiryachikha layers of Chagyrskaya has enabled us to take standard dental measurements according to the technique used by Russian specialists (Zubov 1968). Teeth from other cave sites in the Altai – Denisova and Strashnaya – were also measured. Measurements were compared with those relating to other Middle and Upper Paleolithic Eurasians and to modern geographic groups. Also, nonmetric traits were assessed using the Arizona State University dental anthropology system (Turner, Nichol, Scott, 1991) for *Homo sapiens* and the standards proposed by S.E. Bailey (2002, 2005) for Neanderthals, with special reference to traits which we consider to be most diagnostic. We also

used the summary compiled by A.A. Zubov and N.I. Khaldeyeva (1993). Trait variation was evaluated using the Statistica 8.0 package.

## Results and discussion

### *Minimal number of individuals*

Human remains from Chagyrskaya represent several individuals of various ages. The total number of fragments exceeds 50 (Table 1). Four or five fragments initially diagnosed as human may relate to animals. Others include some 25 skeletal fragments representing one or several adults, two fragments representing immature individual(s), two deciduous teeth, ten isolated permanent teeth, a left maxillary fragment with molars and a partial mandible with the right corpus, and five teeth (a canine, two premolars, and two molars).

The minimal number of individuals was evaluated on the basis of the robusticity of permanent teeth. Maxillary teeth are relatively more gracile than mandibulars. The difference is especially salient when lower premolars are compared with the upper premolar. Another criterion is the wear of permanent teeth. Isolated teeth demonstrate at least two stages of abrasion, implying that two individuals are represented; in addition the abrasion of upper teeth differs from that of lower ones. The interdental facet on the left distal incisor matches that on the left canine. In sum, at least three adults of various ages and possibly of various sexes are represented.

The preliminary examination revealed a numerical predominance of the left side among the postcranial fragments found in 2011. Fragments of right postcranial bones were discovered in 2012. These may all represent one and the same adult individual.

The collection also includes scattered remains of immature individuals. As the abrasion and resorption of the root of the deciduous canine suggest, this tooth may have been lost ante mortem at the age of 9–12. In 2012 another deciduous canine, from the opposite side was found; its size and morphology suggest that it might belong to the same child. Previously, a hand phalanx of an individual no older than 13 was discovered. A thoracic vertebra from the 2012 excavations might belong to a very young adult (Table 1). This specimen disregarded, remains of immature individuals may actually be those of one and the same child aged 9–12, although the topography of finds suggests that there may be two individuals. One more fragment is that of a vertebra of a young child no older than five. Therefore, remains of at least two immature individuals and at least three young adults are present in the sample from Chagyrskaya Cave.

The sample from Okladnikov Cave includes 17 fragmentary specimens representing several individuals (Table 2). Several researchers have attempted to estimate the minimal number of individuals in that sample (Shpakova, Derevianko 2000; Mednikova, 2011; Viola, 2009; Dobrovolskaya, Tiunov, 2011). Their estimates and the results of our assessment of the location of specimens in the habitation layers and of the age of the individuals suggest that at least two children, one juvenile, and one adult are represented. The two latter individuals probably differ with regard to sex.

Therefore the pooled postcranial and dental sample from Chagyrskaya and Okladnikov caves includes the remains of at least three immature individuals and at least four adults.

### *Dental analysis of new finds*

*Deciduous teeth*. Deciduous canines found at Chagyrskaya in 2008 and 2012 are relatively well preserved and suitable for study (Table 3). As noted above, they are probably from one and the same child.

To assess the taxonomic status of this individual, we compared the measurements of the canines with those of the respective teeth of other fossil hominins and modern humans (85 specimens). The variation range of the vestibulo-lingual diameter (VLD) is 4.6–7.7 mm (average, 5.89 mm, standard deviation, 0.60 mm). The dimensions of the Chagyrskaya canines resemble those of certain European and Near Eastern Neanderthals, especially Kebara 4 and Dederyeh 1.

The mesio-distal diameter (MDD) ranges within 4.6–7.9 mm (mean, 6.47 mm; standard deviation, 0.57 mm). In this trait, the Chagyrskaya individual is most similar to late Neanderthals from Spy VI and Arcy sur Cure 3826 and to Qafzeh 15. The Upper Paleolithic child from Listvenka, Middle Siberia, falls within the same cluster.

The crown index, like the absolute dimensions of the teeth, links the Chagyrskaya child with European Neanderthals. Also, the milk canine from Chagyrskaya resembles that from Strashnaya Cave

*Table 1.* **Human fossils from Chagyrskaya Cave (S.V. Markin's excavations 2008–2012)**

| Year, number | Specimens | Strata | Methods of study |
|---|---|---|---|
| 1 | 2 | 3 | 4 |
| 2008 | Right deciduous canine | 6c, horizon 3, sq. L6 | Morphology, micro-CT, microfocus-X-ray |
| 2009 | Fragment of atlas of immature individual | 6b, horizon 4, sq. M8 | Preliminary morphological analysis |
| 2009 | Right premolar | 6c/1, horizon 2, sq. Л8 | Morphology, micro-CT, microfocus X-ray |
| 2009 | Lower permanent incisor with heavily worn crown | 6c/1, horizon 3, sq. M8 | Same |
| 2009 | Fragment of patella (human?) | 6c/1, horizon 3, sq. M8 | Preliminary morphological analysis |
| 2011 | Incomplete right part of mandible with C-$M_2$ | 6c/1, horizon 3, sq. M10 | Same |
| 2011 | Left $I_1$ | 6b, horizon 3, sq. H10, sector 2 | Morphology, micro-CT, microfocus X-ray |
| 2011 | Root of upper (?) permanent incisor | 6b, horizon 3, sq. H10, sector 2 | Same |
| 2011 | Right $M^2$ | 6b, horizon 3, sq. H10, sector 4 | Morphology, micro-CT, microfocus X-ray |
| 2011 | Permanent incisor with heavily worn crown | 6b, horizon 3, sq. H10, sector 4 | Same |
| 2011/1 | Hand phalanx of adult | 6b, horizon 3, sq. H10, sector 2 | » |
| 2011/2 | Distal foot phalanx of adult | 6b, horizon 3, sq. H10, sector 2 | Preliminary morphological analysis |
| 2011/3 | Fragment of occipital bone near the base (human?) | 6b, horizon 3, sq. H10, sector 4 | Same |
| 2011/4 | Patella of adult | 6b, horizon 3, sq. M10, sector 2 | » |
| 2011/5 | Fragment of left ulna of adult | 6b, horizon 3, sq. H10, sector 1 | » |
| 2011/6 | Hand phalanx of immature individual | 6b, horizon 3, sq. O10, sector 1 | » |
| 2011/7 | Distal condyles of left tibia and fibula of adult | 6b, horizon 3, sq. H10, sector 2 | » |
| 2011/8 | Hand phalanx of adult | 6b, horizon 3, sq. H10, sector 2 | » |
| 2011/9 | Five large and several small fragments of pelvic bones of adult | 6b, horizon 3, sq. H10, sector 2 | » |
| 2011/10 | Fragment of vertebra of adult | 6b, horizon 3, sq. H10, sector 2 | » |
| 2011/11 | Fragments of leg bones of adult | 6b, horizon 3, sq. H10, sector 2 | » |
| 2012/1 | Hand phalanx | 5, horizon 4, sq. H11 sector 2 | » |
| 2012/2 | Rib | 6b, horizon 1, sq. H11, sector 4 | » |

*Table 1 (end)*

| 1 | 2 | 3 | 4 |
|---|---|---|---|
| 2012/3 | Two fragments of right clavicle | 6b, horizon 1, sq. M11, sector 1–4 | Preliminary morphological analysis |
| 2012/4 | Calcaneus | 6b, horizon 1, sq. H11, sector 4 | Same |
| 2012/5 | Tarsal bone | 6b, horizon 1, sq. M11, sector 2 | » |
| 2012/6 | Same | 6b, horizon 1, sq. H11, sector 4 | » |
| 2012/7 | Fragment of left maxilla with two molars | 6b, horizon 1, sq. H11, sector 1-4 | » |
| 2012/8 | Metacarpal | 6b, horizon 2, sq. H11, sector 1 | » |
| 2012/9 | ? | 6b, horizon 2, sq. H11, sector 3 | » |
| 2012/10 | Atlas | 6b, horizon 2, sq. H11, sector 1–4 | » |
| 2012/11 | Fragment of axis | 6b, horizon 2, sq. H11, sector 4 | » |
| 2012/12 | Fragment of sternum | 6b, horizon 2, sq. H11, sector 3 | » |
| 2012/13 | Fragments of two foot phalanges | 6b, horizon 2, sq. H11, sector 1–4 | » |
| 2012/14 | Thoracic vertebra of young adult | 6b, horizon 2, sq. H11, sector 4 | » |
| 2012/15 | Lumbar vertebra | 6b, horizon 3, sq. H11, sector 4 | » |
| 2012/16 | Five fragments of distal hand phalanges | 6b, horizon 3, sq. H11, sector 3 | » |
| 2012/17 | ? | 6c/1, horizon 1, sq. H11, sector 4 | » |
| 2012/18 | Carpal bone | 6b, horizon 1, sq. H11, sector 3 | » |
| 2012/19 | Same | 6b, horizon 1, sq. M11, sector 4 | » |
| 2012/20 | ? | 6b, horizon 2, sq. H11, sector 1–4 | » |
| 2012/21 | Carpal bone | 6b, horizon 2, sq. H11, sector 2 | » |
| 2012/22 | Permanent $I^2$ (left?) | 6b, horizon 2, sq. H11, sector 3 | » |
| 2012/23 | Carpal bone (?) | 6b, horizon 3, sq. H11, sector 3 | » |
| 2012/24 | Permanent maxillary canine (left?), articulates with No. 2012/22 | 6c/1, horizon 1–3, sq. H10, M11 | » |
| 2012/25 | Lower left deciduous canine | 6c/1, horizon 3, sq. M10, sector 1 | » |
| 2012/26 | ? | 6c/1, horizon 3, sq. H10, sector 1 | » |
| 2012/27 | Lower premolar ($P^3$, left?) | 6c/1, horizon 3, sq. M10, sector 4 | » |
| 2012/28 | Phalanx (?) | 6c/1, horizon 1, sq. O11, sector 3 | » |
| 2012/29 | Fragment of crown of permanent tooth (?) | 6a, horizon 3, sq. O11, sector 3 | » |

*Table 2.* **Human fossils from Okladnikov Cave (V.T. Petrin's excavations, 1984)**

| No. | Specimens | Stratum | Methods* |
|---|---|---|---|
| 1 | Fragment of right patella of adult | 1, under roof, sq. Д1 | Morphological; isotopic |
| 2 | Fragment of left fifth metatarsal of adult | 1, under roof, sq. Д1(?) | Morphological |
| 3 | Crown of left third lower molar | 2, under roof, sq. В2 | Same, micro-CT |
| 4 | Fragment of left talus of adult | 2, under roof, sq. В4 | Morphological |
| 5 | Distal fragment of right femur of immature individual | 2, under roof, sq. Г3 | Same, CT, isotopic |
| 6 | Fragment of right calcaneus of adult | 2, under roof, sq. Д1 | Same |
| 7 | Right (?) navicular of immature individual | 2, under roof, sq. Д2 | Morphological, CT |
| 8 | Fragment of left calcaneus of adult | Same | Morphological, isotopic |
| 9 | First or second lower molar | 3, under roof, sq. А2 | Morphological, micro-CT |
| 10 | Distal fragment of right humerus of immature individual | 3, under roof, sq. Б1 | Morphological, CT, isotopic |
| 11 | Lower first premolar | 3, under roof, sq. Б2 | Morphological, micro-CT |
| 12 | Second right (?) medial hand phalanx of adult | 3, under roof, sq. В1 (?) | Morphological |
| 13 | Distal fragment of right humerus of adult | 3, under roof, sq. В2 | Same, isotopic |
| 14 | Proximal fragment of left femur of immature individual | 3, under roof, sq. Г4 | Same, CT |
| 15 | Left (?) third or fourth medial hand phalanx of adult | 3, under roof, sq. Г4 | Morphological |
| 16 | Crown of lower third molar | 3, under roof, sq. Е1 | Same, micro-CT |
| 17 | Second right lower deciduous molar | 7, gallery 1, sq. М6 (?) | Same |

*Results published in (Shpakova, Derevianko, 2000; Mednikova, 2011; Viola, 2009; Viola et al., 2011; Buzhiova, 2011; Dobrovolskaya, Tiunov, 2011).

in the Altai (its archaeological context is unclear) (Derevianko, 2011). Hopefully, further excavations will serve to expand on the significance of this comparison.

The right second deciduous molar from Okladnikov Cave has been examined in detail on more than one occasion (see (Shpakova, Derevianko, 2000) for references). To assess its taxonomic position we compared it with teeth of 102 hominins associated with various Paleolithic traditions. Their VLD varies within 8.0–10.2 mm (mean, 9.2 mm; standard deviation, 0.58 mm). No geographic or temporal variation is observed. Interestingly, molars from Okladnikov Cave, Denisova, and Strashnaya are rather similar in shape while differing in absolute dimensions. They are all intermediate between the teeth of European Neanderthals and Near Eastern Mousterians (the Okladnikov Cave specimen resembles Châteauneuf 2 and Skhul 10, whereas the child's molar from Strashnaya is close to those of Les Rois R50/33 and Qafzeh). The Denisova child displays dental affinities with Roc de Marsal, La Chaise 13 and Qafzeh 4. The Strashnaya tooth is rather robust, like that of the Staroselye child.

The variation range of MDD is 9.2–11.6 mm (mean, 10.4 mm; standard deviation, 0.60 mm). Like the preceding character, it reveals virtually no differentiation between Eurasian hominins. Robust teeth of European Neanderthals tend to be opposed to relatively gracile teeth of Upper Paleolithic children. The position of molars from Okladnikov Cave and Strashnaya is virtually the same as with

*Table 3.* **Dimensions of human teeth from the Paleolithic cave sites in the Altai**

| Teeth | Mesio-distal diameter | Vestibulo-lingual diameter | Notes |
|---|---|---|---|
| 1 | 2 | 3 | 4 |
| *Denisova Cave* | | | |
| $m_2$ | 10.3 | 9.3 | – |
| $i_1$ | 4.7 | 4.8 | – |
| *Okladnikov Cave* | | | |
| $m_2$ | 10.0 | 8.6 | – |
| $P_1$ | 6.6 (?) | 8.6 | – |
| $M_1$ | 11.0 | 10.3 | – |
| $M_3$ | 11.6 | 10.2 | – |
| $M_3$ | 12.1 | 10.6 | – |
| *Chagyrskaya Cave* | | | |
| *c* (lower right, 2008) | 6.7 | 6.1 | – |
| *c* (lower left, 2012/25) | 6.8 | 6.3 | – |
| $I_1$ (2011) | 4.8 | 6.7 | – |
| $I_?$ (2011) | – | – | – |
| $I_{1?}$ (2009) | – | 6.8 | – |
| C (right, 2011) | 7.2 | 8.2 | |
| $P_3$ (right, 2011) | 7.2 | 9.2 | |
| $P_4$ (right, 2011) | 6.5 | 9.4 | Single fragment |
| $M_1$ (right, 2011) | 10.1 | 11.6 | |
| $M_2$ (right, 2011) | 11.02 | 11.3 | |
| $P_3$(left, 2012/27) | 6.7 | 8.2 | – |
| $I^?$ (2011) | – | – | – |
| $I^2$ (left, 2012/22) | – | 7.4 | Articulates with No. 2012/24 |
| *C* (upper left, 2012/24) | – | 9.9 | Articulates with No. 2012/22 |
| $P^4$ (right, 2009) | – | 9.6 | |
| $M^1$ (left, 2012/7) | 9.2 | 11.5 | Single fragment |
| $M^2$ (left, 2012/7) | 9.8 | 11.5 | |
| $M^2$ (right, 2011) | 9.9 | 11.4 | – |
| (permanent?, 2012/29) | – | 10.8 | – |

*Table 2 (end)*

| 1 | 2 | 3 | 4 |
|---|---|---|---|
| *Strashnaya Cave* | | | |
| *C* | 7.0 | 6.5 | – |
| $M_1$ | 10.0 | 8.0 | – |
| $M_2$ | 11.6 | 10.1 | – |
| *C* | 7.5 | 8.4 | – |
| $P_3$ | 8.3 | 8.7 | – |
| $M_2$ | 12 (?) | 12 (?) | – |
| $I^2$ | 7.0 | 6.5 | – |
| $P^4$ | 8.3 | 11.3 | – |

regard to VLD. The child from Okladnikov Cave resembles certain European Neanderthals as well as Qafzeh 4 and Shanidar 7 and robust Upper Paleolithic specimens like Pavlov 8 and Malta 2. The robust tooth from Strashnaya is similar to Les Rois R50/33. The Denisova tooth differs from other Altaian specimens, resembling Dederyeh 2 and Amud 3.

The crown index links the Okladnikov Cave individual with the Combe Grenal Neanderthal, whereas the child from Strashnaya resembles another Neanderthal found in France – Les Rois R50/33. In terms of the robusticity index the Okladnikov Cave deciduous molar is similar to robust molars of Upper Paleolithic children such as Pavlov 7 and 8.

*Permanent teeth.* Dental remains found in the Middle Paleolithic layers of Chagyrskaya include three lower and two upper incisors, and two canines (one lower and one upper) (Table 3). Unfortunately, their poor state of preservation prevents us from assessing their taxonomic affinities. The preserved roots are short and robust. Their length (14.1 mm; 14.1 mm; and 16.2 mm in lower teeth, and 15.6 in the upper tooth) places these individuals between Neanderthals and Upper Paleolithic humans (Bailey, 2005: 205).

The crowns are nearly entirely worn away. One incisor displays a lingual cusp, which is rather frequent in Neanderthals (Bailey, 2002). The VLD of the Chagyrskaya incisor (comparative sample: 95 specimens, mean, 6.7 mm, standard deviation, 0.50 mm) is less than in European Neanderthals and close to the values shown by Near Eastern humans (Table 3).

The canines of the Chagyrskaya hominin are robust and they are of similar proportions. Due to the poor state of preservation of the crowns only the MDD and VLD of the mandibular teeth and the VLD of the maxillary teeth were analyzed (Table 3). With regard to VLD the lower canines of the first individual from Chagyrskaya are similar to the gracile extreme of the Neanderthal range and to average Upper Paleolithic humans (comparative sample: 94 individuals; mean, 8.7 mm; standard deviation, 0.7 mm). The VLD of the maxillary canines of another individual is similar to the European Neanderthal average (comparative sample: 82 specimens; mean, 9.4 mm; standard deviation, 0.7 mm).

The root length of the first mandibular premolar from Chagyrskaya (Table 3) measures 14.3 mm and falls within the variation ranges of both European Neanderthals and Upper Paleolithic humans (Bailey, 2005: 205). The crown dimensions of the lower left premolar from Okladnikov Cave do not enable us to link this individual unambiguously with Neanderthals. In C.G. Turner's view, this tooth does resemble the teeth of the Neanderthals of France and the Near East (Turner, 1990). However, a larger comparative sample (88 specimens; mean VLD, 8.8 mm; standard deviation, 0.6 mm) suggests that the premolar from Okladnikov Cave is similar to the most gracile Neanderthal teeth and to the most robust teeth of Upper Paleolithic Europeans. In other words, it falls within the overlap zone between Neanderthals

and anatomically modern humans. According to B.T. Viola (2009), nonmetric traits align this specimen to Neanderthal premolars.

Returning to the $P_3$ from Chagyrskaya, its MDD is larger than in the specimen from Okladnikov Cave, linking the former with European Neanderthals. The proportions of the $P_3$ from Strashnaya, too, are similar to those of Neanderthal teeth (Table 3).

The second premolars were found in Chagyrskaya and Strashnaya. $P^4$ from Strashnaya, like its counterpart from Obi-Rakhmat, is closest to Neanderthal teeth (Ibid.). The proportions of $P_4$ from Chagyrskaya, on the other hand, are close to those of all Paleolithic hominins and even of modern humans. The VLD in the comparative sample (96 specimens) equals 8.9 mm (standard deviation, 0.6 mm). Nonmetrically, however, the Chagyrskaya specimen is asymmetrical. It has a well developed metaconid and a transverse crest (see Figure), linking it with Neanderthal teeth (see (Bailey, 2002) for a summary of nonmetric trait frequencies in Neanderthals).

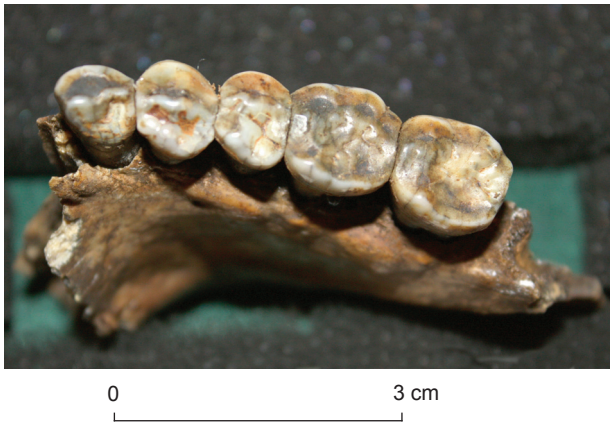
The dimensions of the left $M_1$ from Okladnikov Cave are within the variation range of molars of all Late Pleistocene hominins; the mean VLD in the comparative sample (139 specimens) is 11.2 mm with a standard deviation of 0.6 mm. Unfortunately, dimensions of those teeth are of little taxonomic value.

Nonmetrically, however, the $M_1$ from Okladnikov Cave appears more archaic than the premolar from that site. It has a distinct anterior fossa and accessory cusps, contributing to a wrinkled occlusal surface. However, as already noted, it has no distinct epicristid (midtrigonid crest), which is virtually universal in European Neanderthals, whereas the archaic traits listed above are not specifically Neanderthal. By contrast, $M_1$ from Chagyrskaya demonstrates both the epicristid and the anterior fossa (see Figure).

The right $M_2$ from Chagyrskaya is metrically closest to Neanderthal molars; the mean VLD in the comparative sample (127 specimens) equals 11.0 mm with a standard deviation of 0.7 mm. Despite a slight abrasion of the occlusal surface the epicristid and the anterior fossa are quite distinct (see Figure).

The root length of the right $M^2$ from Chagyrskaya (17.9 mm) borders on maximal values in European Neanderthals, suggesting that the individual was a Neanderthal. The same is true of the dimensions of the other molar.

The right and left crowns of $M_3$ from Okladnikov Cave, as E.G. Shpakova correctly noted, may be from one and the same individual (Shpakova, Derevianko, 2000). Their dimensions fall in the overlap zone between smallest Neanderthal values and largest values in Upper Paleolithic Europeans; VLD in the comparative sample (67 specimens) is 10.7 mm, standard deviation, 0.7 mm.




Partial mandible from stratum 6c/1 in Chagyrskaya Cave (discovered in 2011).

Nonmetrically these crowns display archaic traits such as a highly wrinkled occlusal surface, anterior fossa, accessory cusps, and complicated furrow pattern. These traits, however, do not indicate specifically Neanderthal affinities. As mentioned, B.T. Viola's CT study of the first and third molars from Okladnikov Cave has revealed the presence of epicristid on the dentin surface, which points to looking in a Neanderthal direction. Generally, however, the trait combination is somewhat unusual (Viola, 2009).

## Conclusions

The crown dimensions of deciduous teeth place the Neanderthals of the Altai between other European Neanderthals and modern humans. These teeth resemble the robust deciduous teeth of European Neanderthals, Upper Paleolithic humans, and early Near Eastern humans.

Fragmentary as they are, the anterior deciduous teeth point to a possible continuity between Neanderthals of the Altai and certain Upper Paleolithic Siberians such as Listvenka and possibly Strashnaya. The deciduous molars can be compared to the robust teeth of Upper Paleolithic Europeans and probably those of Siberians such as Malta. New data are required to verify these conclusions.

The combination of traits displayed by permanent teeth from Okladnikov Cave is not specific. Dimensions variously link them with Neanderthal teeth and with the robust teeth of Upper Paleolithic humans, whereas nonmetric traits are mostly archaic but not specifically Neanderthal.

New fossils from Chagyrskaya reveal a distinctly Neanderthal combination of traits: anterior fossa and epicristid on lower molars, metaconid and crest on premolars (Viola et al., 2012). Generally, certain traits, both metric and descriptive, link the Okladnikov Cave and Chagyrskaya hominins with both Neanderthals and Upper Paleolithic humans, whereas others clearly indicate Neanderthal affinities. This combination of archaic and more advanced traits may represent a distinctive characteristic of the Altai Neanderthals.

In sum, the dentition of this geographic group of Neanderthals places them between other Neanderthals of Eurasia and anatomically modern humans. It is hoped that future finds will shed light on the migration routes whereby the Neanderthals reached the piedmonts of the Altai.

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