Sacrifice Horse Remains from Late Bronze-Early Iron Age of South Moldova: A Study of Dental and Limb Bone Morphology

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Received: May 22, 2017 **| Published:** June 21, 2017

Abstract

The article describes dental and postcranial remains of ancient domestic horses of various individual ages from the archaeological monuments of Belozerla Culture Novosiolovca-1 and Olanesti (Southern Moldova). Upper cheek teeth of the horses under study are characterized by relatively long and variable in shape protocone. Single preserved metacarpal and metatarsal bones from Novosiolovca-1 are quite elongated and slender, showing a close resemblance to the mean measurement values of horse remains from Late Bronze age and Early Iron Age from Southeast Europe. Phalanxes of the horses from Novosiolovca-1 and Olanesti are comparatively slender and elongated. Generally, the postcranial measurements of the horses under study correspond to the semi-thin legged type with "average height" in withers (144-136 cm). One of horse individuals from Novosiolovca-1 shows a specific wear of second upper molar caused by a snaffle bit.

Keywords: Domestic Horse Remains; *Equus ferus caballus*; Eastern Europe; Belozerka Culture; Late Bronze; Early Iron Age.

Introduction

Horse is a particular domestic animal, since its domestication deeply influenced social-political evolution and events soon after horse riding was invented. The horse riding and equestrian transport enabled rapid communications, political and economic expansions, standardization of language, law, weights, measures and writing systems over entire continents, as well as dissemination of revolutionary technologies and ideas [1-3]. The current multidisciplinary research efforts are mostly focused upon the problem of chronology and cultural context of horse domestication [4-7]. Nonetheless, the detailed morphology ancient domestic and predomestic horses from the critical for the horse domestication areas of North Pontic and Caspian steppes remain unstudied or superficially described, despite of available rich archaeozoological material. Therefore, our knowledge on ancient domestic horses from Eurasian steppes still remains incomplete and new thoroughly collected data are needed to improve our understanding of horse breeding in the past as a source of data reflecting social, cultural and economical-political processes in the core area of horse domestication.

The present article is a contribution to the study of detailed morphology of ancient domestic horse that presents a description of horse remains from two Belozerka Culture sites from South Moldova excavated by S. Agulnikov and S. Popovici from Novosiolovca-1 (= Novoselovka) in 2013 (Taraclia District, Moldova) and from Olanesti in 2014 (Stefan Voda District, Moldova) (Figure 1). Both archaeozoological complexes represent remains of sacrificed domestic animals [8]. The horse remains from Novosiolovca-1 (143 bone fragments that belong to 5 individuals) were found in association with four poorly preserved bones of hind limb (fragment of metatarsus, second phalanx and two small tarsal bones) of cattle (*Bos taurus*) bones and three isolated teeth (M^2, M^3, M_3) of ruminants or caprines (sheep *Ovis aries* or goat *Capra hircus*). The

archaeozoological material from Olanesti is represented by heavily fragmented bone remains of three horse individuals, therefore only isolated teeth and phalanxes were suitable for morphological study.

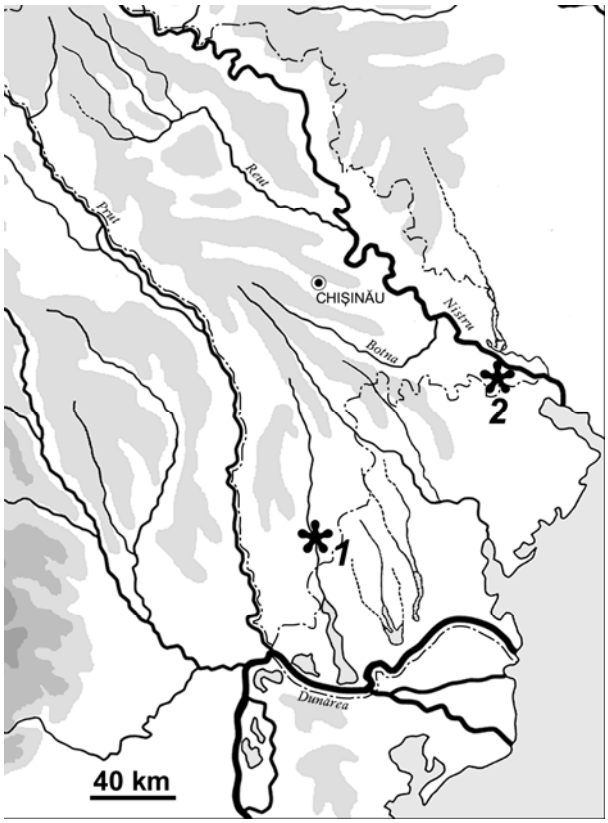

Figure 1: Geographical position of the archaeological sites of Belozerka Culture considered in the present communication: 1, Novosiolovca-1; 2, Olanesti.

Some comments on zoological nomenclature of domestic and Eurasian wild horses are necessary in order to clarify the taxonomy of equid species and forms involved in the present study. Linnaeus [9] based his original description of Equus caballus on the references to publications of Gesner [10], Aldrovandi [11], Jonston [12], and Ray [13]. Therefore, the descriptions and figures published by the above mentioned pre-Linnaean authors create an integral part of the species description according to the Article 72.4.1 of the International Code of Zoological Nomenclature (ICZN). It is important to keep in mind that all pre-Linnaean descriptions used for Linnaean's horse species *Equus caballus* are based on domestic breeds of horses [10-13]. According to the Opinion 2027 of the International Commission of Zoological Nomenclature [14], the species name based on a wild ancestral form has priority over the species name based on a domestic form, even if a domestic form was described and published simultaneously or earlier. Therefore, Equus ferus Boddaert 1785 has priority over *Equus caballus* Linnaeus 1758. Groves [15] considers that the species name Equus gmelini Antonius 1912 broadly used in Russian literature for wild tarpan from Eastern Europe is a junior synonym of Equus ferus Boddaert 1785, which is also based on Gmelin's [16] original description. I accept the viewpoint of Groves [15]. The trinomen *Equus ferus caballus* Linnaeus 1758 for domestic horse is frequently used in modern scientific literature [17].

Material and Methods

The skeletal horse remains from Novosiolovca-1 is represented by cranial fragments, isolated teeth, complete well preserved metatarsus, metacarpus, talus, posterior first phalanx, anterior and posterior second phalanxes, fragments of humerus, radius, ulna, femur, tibia, fragments of ribs, atlas, epistropheus, as well as a fragment of metapodium of a juvenile individual. The various degree of tooth wear permitted to separate the cheek teeth of different individuals found in the archaeozoological complex. The archaeozoological complex from Olanesti consists of heavily damaged and poorly preserved skeletal remains that belong to three horse individuals (the number of individuals is deduced from the better preserved tali). One of individuals is juvenile with deciduous teeth. Another senile individual is represented by deeply worn isolated cheek teeth. The third individual is represented by isolated molars on the earlier stage of tooth wear (teeth are worn approximately at 1/3 of tooth crown height). The available for morphological study material included the better preserved four M^2, one M^3, one posterior first phalanx, three anterior second phalanxes and one posterior second phalanx.

The state of preservation of the osteological material restricted the choice of methodological approach. The description of horse remains includes morphology of cheek teeth, as well as proportions of metapodials and phalanxes. A special attention is focused upon the morphological variation of teeth that allowed to estimate the character of individual variation, but also permitted to reassemble the isolated cheek teeth in tooth rows in cases when the individuals under study show a similar degree of dental wear.

The estimation of the height in the withers based on long bone lengths proposed by Vitt [18] is an important parameter for horseback riding and therefore it is applied in the present study. The classification of metapodial robustness in horses proposed by Brauner [19] is also taken in consideration. The terminology of horse dental morphology is applied from Gromova [20]. The measurements are taken according to Gromova [20] and Kuzmina [21]. The medial length of phalanxes is used in the present study. The anterior and posterior phalanxes are distinguished according to criteria published by Kuzmina [12]. The relative length of protocone is calculated as: L tooth crown / L protocone 100. The abbreviations used in the text and tables: P: premolar; M: molar; L: length; D: breadth; ant: anterior; post: posterior; prox: proximal; dist: distal; diaph: diaphysis; Lpr: length of protocone; %pr: relative length of protocone; DLM: latero-medial measurement; DAP: antero-posterior measurement.

Description

Dental remains from novosiolovka-1

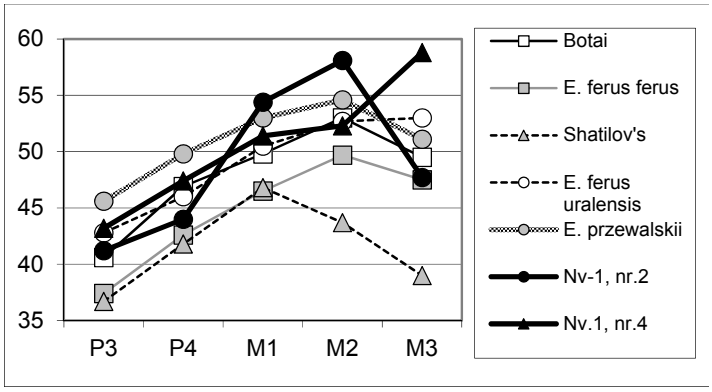

Figure 2: Relative length of protocone in domestic and wild horses in comparison with individuals 1 and 4 from Novosiolovca-1 (Nv.-1). The samples and specimens involved in the comparison: Shatilov's tarpan [11], modern wild horse *Equus przewalskii* [12], extinct Late Pleistocene and Early Holocene horse *Equus ferus uralensis* [12], Eneolithic horse from Botai [12], sub-fossil tarpan *Equus ferus ferus* [12].

Individual 1: The juvenile individual is characterized by presence of functional molars at the initial stage of wearing and the deeply worn deciduous teeth, which soon should be changed with permanent premolars. The individual age at the moment of burial was around 3 years old.

Individual 2: This is a senile individual characterized by an advanced stage of tooth wear. Premolars are characterized by relatively short protocone with a small notch on the lingual side. The protocone is relatively long, especially in M^1 and M^2 (the highest value of protocone length index among the compared specimens and samples), but apparently, the extremely long protocones in molars resulted from the advances degree of dental wear (Figure 2). The anterior edge of P^2 is sharp and does not show a characteristic damage caused by bit (possibly, because of its senile age). The measurements of assembled tooth rows are shown in the Table 1.

Individual 3: This is a mature individual characterized by medium degree of tooth wear. The lingual notch in protocone of upper molars and premolars is not clearly expressed. The lingual wall of protocone is straight in right M^1, with small notch in right P^4 and is undulated in the rest cheek teeth. The some-what swollen basal parts of P^3 and P^4 crowns represent a peculiar characteristic of this individual. The protocone is comparatively long, especially in premolars (Table 2). The grinding surface of P2 is sloped toward the

anterior; its anterior edge is rounded as it was shown by Bendrey [22] for domestic horses that wear a snaffle with bit.

Individual 4: The degree of dental wear is the same as in the previous individual. Teeth are characterized by similarly swollen basal parts of their crowns. The lingual notch of protocone is clearly expressed in molars. This notch is less sharp in premolars and in some cases the lingual wall of protocone is rather concave than notched. The protocone is relatively long (especially in M^3), as in the presumed domestic horse from the Eneolithic site of Botai and in wild extinct Equus ferus uralensis Kuzmina 1975 (Late Pleistocene of Southern Ural Area) (Table 3, Figure 2).

Individual 5: The cheek teeth are on the medium stage of tooth wear. As in two previous individuals, the basal parts of crowns of M^3 and P^4 are somewhat swollen. The lingual wall of protocone of P^4 is rather undulated (with a broad shallow notch). It is slightly undulated and concave in M^2 and bears a sharp notch in M^3. This individual is also characterized by relatively long protocone, especially in M^2 (Table 4), which approaches the length of protocone in the individual 2 with deeply worn teeth. Therefore, one can draw a conclusion that the particularly long protocone in some individuals of the sample from Novosiolovca-1 represents a specific morphological peculiarity, but not just a consequence of advanced dental wear.

Dental remains from Olanesti

The sample contains deeply worn deciduous teeth and permanent cheek teeth on the initial stage of wear, indicating the young individual age of sacrificed animals. The isolated upper cheek teeth are poorly preserved, therefore, the detailed morphology and individual morphological variation could not be recorded. The measurements are presented in the Table 5. The differences in measurements of upper molars are caused by the different stage of tooth wear: smaller teeth are more deeply worn. Nonetheless, it seems that the degree of tooth wear did not affect the relative length of protocone. The relative length of protocone, with exception in one left M^2, exceeds 50% of the tooth crown length. The horse individuals from Novosiolovca-1 and Olanesti are distinguished from wild tarpan *Equus ferus ferus* Boddaert 1785 by the relatively long protocone and elongated second phalanxes.

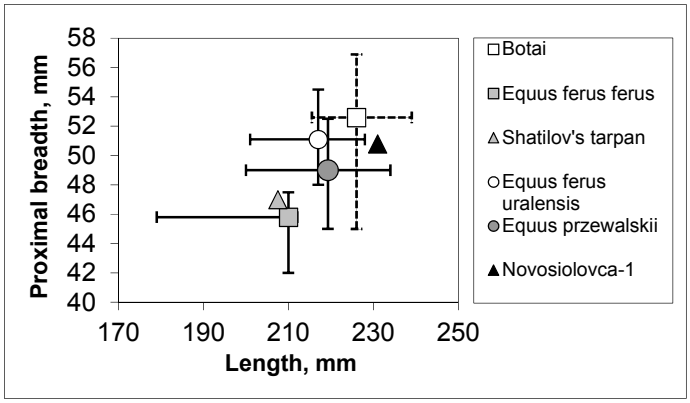

Figure 3: Comparison of main measurements (total length and proximal epiphysis breadth) of the metacarpal bone from Novosiolovca-1 [11, 12].

Metapodials from Novosiolovca-1

The height in the withers based on the metacarpal and metatarsal bones attained, if one apply Vitt's [18] methodology, to 144-136 cm that corresponds to the "average height" in withers. This is one of the most frequent categories (42.9% of the total number of identified individuals: Zalkin [23]) of Iron Age horses from steppe zone of Eastern Europe that is just insignificantly lower in number than the group of "stunted" horses (47.3%) with height in withers varying between 136 and 128 cm [23].

According to the relative robustness of diaphysis (15.0%), the metacarpal bone from Novosiolovca-1 falls within Brauner's [19] "semi-thin legged" group of domestic horses that represents the most frequent type of horses from Early Iron Age (50% of the total number of metacarpals) studied by Zalkin [24]. The metacarpal bone under study falls within the variation range of the presumed earliest domestic horse from Botai (Kazakhstan) and is relatively longer than metacarpals of *Equus ferus uralensis* (Figure 3). The

diaphysis robustness of metatarsal bone from Novosiolovca-1 (11.8%) also falls within the most frequent variation type and is close to the mean value (11.95%) of the sample studied by Zalkin [24].

Phalanxes

The first phalanxes under study where defined as posterior due to their relatively thin diaphyses [21]. The posterior first phalanxes are significantly larger than in the only known complete Shatilov's tarpan *Equus ferus ferus* and the series of sub-fossil remains of tarpan described by Kuzmina [21]. The main measurements of posterior first phalanxes from Novosiolovca-1 and Olanesti approach them to the single known phalanx from Uch-Bash (Crimea, Ukraine) and to the mean values of the sample from Botai (Figure 4). The specimens from Novosiolovca-1, Olanesti and Uch-Bash, as well as the phalanxes from Botai are relatively somewhat longer than the posterior first phalanxes of *Equus ferus uralensis*, although the data are overlapping. One can notice also quite thin diaphyses of the specimens from Moldova (Figure 4).

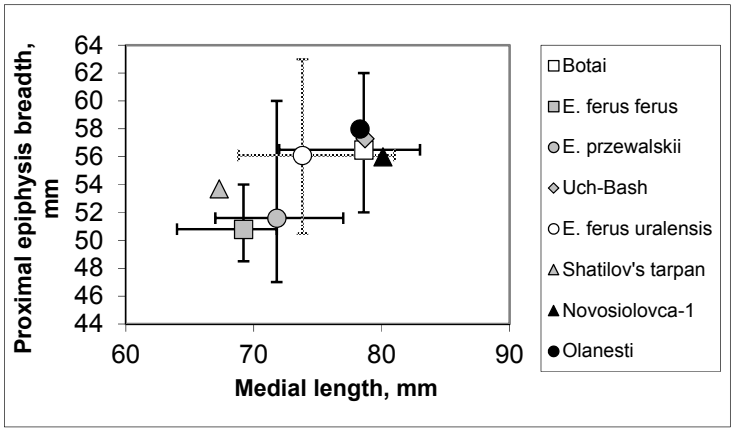

Figure 4: Size and proportions of first posterior phalanxes of domestic and wild horses in comparison with specimens from Novosiolovca-1 and Olanesti [11,12].

The anterior second phalanxes from Olanesti are significantly larger than those of wild tarpan *Equus ferus ferus* and falls within the range of variation of *Equus ferus uralensis* and the horse from Botai. The anterior second phalanx from Novosiolovca-1 is peculiar. It is relatively longer and slender due to the narrower proximal epiphysis, but still falls within the variation range of the sample from Botai (Figure 5). The specimen from Novosiolovca-1 and the anterior second phalanxes from Uch-Bash are also characterized by relatively narrower diaphysis (Figure 5). Therefore, the slender proportions of the second phalanx from Novosiolovca-1 approach it to the sample from Early Iron Age of Uch-Bash and distinguish this group of specimens from the rest of material involved in the study.

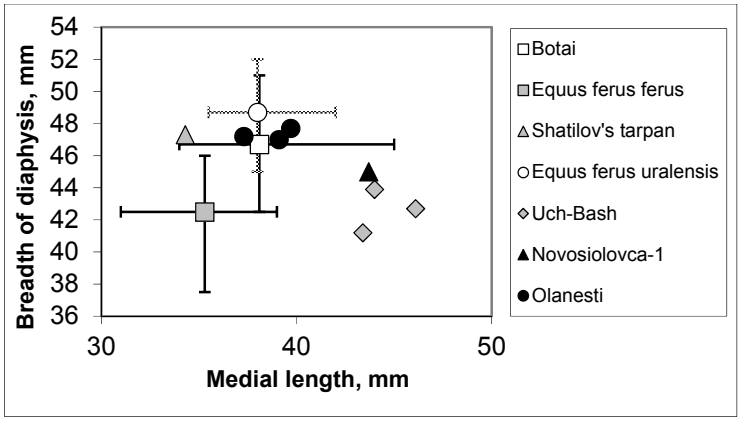

Figure 5: Size and proportions of second anterior phalanxes of domestic and wild horses in comparison with specimens from Novosiolovca-1 and Olanesti [11,12].

Discussion and Conclusion

Despite of a limited number of publications dedicated to horses from Late Bronze and Early Iron Age of Southeast Europe, this group of horses is still better studied than horses from other cultures of the region. The first important research on horse remains from the tumulus burials of Tiraspol District belongs to Brauner [19]. Brauner proposed a new methodological approach in

horse craniometry and a classification of domestic horse types based on metapodial robustness. Much later, Zalkin [23] carried out a biometric study and statistic analysis of a rich archaeozoological material of horse remains from North Pontic area and arrived to the conclusion that the Early Iron Age horses were comparatively robust with low (128-136 cm) and average (136-144 cm) height in withers, but still larger if compared to the horses from Early Iron Age of North Europe. According to Zalkin [24,25], there are no statistically reliable differences between horses from Late Bronze Age, Early Iron Age, and horse remains of Czernyakhov Culture of Roman Age from Eastern Europe. The studies of Zalkin [23-25] were focused mostly upon long limb bones and first phalanxes. Quite limited in number horse remains from the Early Iron Age of Uch-Bash (Crimea, Ukraine) are characterized by a variable relative length of protocone of upper molars with a small notch on its lingual side and relatively long second phalanxes [6].

The horses from Novosiolovca-1 and Olanesti generally are characterized by relatively long protocone: the index of protoconal length is higher than 40% in P3, higher than 45% in P4 and with few exceptions, higher than 50% in upper molars. Some teeth from Novosiolovca-1 are characterized by the longest protocone among the specimens and samples involved in the comparison. The length of protocone approaches the ancient domestic horses under study to the group of horses with long protocone (domestic horse from Botay, *Equus ferus uralensis*, *Equus przewalskii*) and distinguishes them from the wild European tarpan *Equus ferus ferus*. The shape of protocone is a variable character in the ancient horses from Moldova: the studied material contains cheek teeth with undulated, concave, or notched lingual wall of protocone. The shape of protocone may also be variable in different teeth of the same individual. Among the observed individual variation of tooth morphology should be mentioned also the swollen basal parts of cheek tooth crowns found in some of individuals from Novosiolovca-1.

The metapodials are poorly represented in the studied material, however, they bring an important information on “typical” physical parameters of the Belozerka horses from Moldova or, at list, one of the buried individuals from Novosiolovca-1, which is characterized by the average height in withers (144-136 cm according to the classification of Vitt [18] and semi-thin metacarpal bones (according to the classification of Brauner [19]). Ancient Belozerka domestic horses are characterized by relatively longer phalanxes. Probably, this is a characteristic trait of all ancient domestic horses from Eastern Europe and Northern Kazakhstan. It is necessary to mention here the particularly slender and elongated second anterior phalanxes from Novosiolovca-1 and Uch-Bash. At list, one of the sacrificed animals from Novosiolovca-1 (the individual 3) was a saddle horse; this conclusion is based on the characteristic wearing of the second upper premolar caused by a snaffle bit. Finally, it should be noted that the sacrificed Belozerka horses have rather aleatory character: they belong to various age groups and apparently represent the most common physical type of Late Bronze-Early Iron Age horses.

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Citation: Croitor R (2017) Sacrifice Horse Remains from Late Bronze-Early Iron Age of South Moldova: A Study of Dental and Limb Bone Morphology. J His Arch & Anthropol Sci 1(3): 00019. DOI: 10.15406/jhaas.2017.01.00019

Table 1: Measurements and relative length of protocone of the assembled tooth rows of the individual 2 (senile).

Measurements		**P^2**	**P^3**	**P^4**	**M^1**	**M^2**	**M^3**
sin	L	34.1	27.2	25.5	22.6	24.6	30
	D	23	27.3	27.4	27.8	28.3	24.8
	Lpr	8.2	11.2	11.2	12.3	14.3	14.3
	%pr	24	41.2	44	54.4	58.1	47.7
dx	L	34.7	26.8	26	23.2	24.6	
	D	23.6	27	27.8	28	28.5	
	Lpr	8.2	11.1	11.7	12.3	14.2	
	%pr	23.6	41.4	45	53	57.7	

Table 2: Measurements and relative length of protocone of the assembled partial upper tooth series of the individual 3 (mature).

Measurements		**P^2**	**P^3**	**P^4**	**M^1**
sin	L	37.5	30.2	29.6	26
	D	25	28.8	30.3	28.8
	Lpr	9.4	12.9	14.1	12.3
	%pr	25.5	42.7	47.6	47.3
dx	L	38.2	30.4	30.2	
	D	26	28.9	30	
	Lpr	10.2	12.7	13.9	
	%pr	26.7	41.8	46	

Table 3: Measurements and relative length of protocone of the assembled left tooth row and isolated right M^3 of the individual 4 (mature).

Measurements	**P^3 *sin***	**P^4 *sin***	**M^1 *sin***	**M^2 *sin***	**M^3 *sin***	**M^3 *dx***
L	28.5	27.4	23.9	25.2	27.2	27.1
D	27.6	27.9	26.5	26.6	23.5	24.3
Lpr	12.3	13	12.3	13.3	16	14.5
%pr	43.2	47.4	47.3	52.3	58.8	53.5

Table 4: Measurements and relative length of protocone of the isolated upper cheek teeth of the individual 5 from Novosiolovca-1.

Measurements	**P^4 *dx***	**M^2 *sin***	**M^3 *dx***
L	27	25.8	28.3
D	29	27.6	25.1
Lpr	12.4	14.7	13.6
%pr	46	57	48.1

Table 5: Measurements and relative length of protocone of the isolated upper cheek teeth from Olanesti.

Measurements	**M^2 *sin***	**M^2 *sin***	**M^2 *dx***	**M^2 *dx***	**M^3 *dx***
L	31	25.1	30.8	25.2	25.7
D	25.1	24.1	29.9	24.2	25.3
Lpr	14	12.6	16.7	13	13.4
%pr	45.1	50.2	54.2	51.9	52.1

Table 6: Measurements of horse postcranial remains from Novosiolovca-1 (Nv) and Olanesti (Ol).

Specimen	**L**	**DLM prox.**	**DAP prox.**	**DLM diaph.**	**DLM dist.**	**DAP dist.**
Rd, Nv.					74.7	41.0
Tb, Nv.					76.4	46.5
Mc, Nv.	231	50.8	34.4	34.7	52.0	36.4
Mt, Nv.	272	52.6	46.3	32.0	54.2	41.7
Ph. I post, Nv.	80.1	56.0	29.0	34.4	46.9	25.9
Ph. I post, Ol.	78.3	58.0	31.6	36.1	45.5	27.6
Ph. II, ant., Nv.	43.7	51.4	30.8	45.0	51.5	27.2
Ph. II, ant., Ol.	37.3	52.6	30.5	47.2	51.2	27.3
Ph. II, ant., Ol.	39.7	58.1	31.7	47.7	52.2	26.5
Ph. II, ant., Ol.	39.1	52.8	31.3	47.0	51.7	28.3
Ph. II, post., Ol.	40.0	53.3	34.8	44.2	48.2	28.5