**Slide 1**

Title slide

**Slide 2**

Dental cementum grows throughout the animals’ life and remains in fossils. Studying dental cementum is a well-proven method of determining seasons of death of mammals, including horses (equids) (e.g. Spiess, 1976; Klevezal, 1988; Beasley *et al*., 1992; Burke, 1992; Lieberman & Meadow, 1992; Lieberman, 1994; Burke & Castanet, 1995; Greenfield *et al.*, 2015).

On this slide you can see an example of image of horse’s dental cementum we worked with. This image illustrates a part of a longitudinal section of M1 of *Equus ferus* from the Upper Paleolithic site Kostenki 14.

Growth layers of tooth cementum have different optical characteristics and are visible under microscope as a sequence of light and dark bands. Every year, a new main layer of cement forms. This annual layer consists of summer element (growth zones) and winter element (annuli and/or lines of arrested growth (LAG)).

The growth zones correspond to active cementum growth. The annuli correspond to periods of slow growth. LAGs are the result of growth cessation. When LAGs are present, they canи be situated within annuli, otherwise they are present alone. (Klevezal, 1988; Burke, 1992; Burke & Castanet 1995; Greenfield *et al.*, 2015).

**Slide 3**

In our study, we worked with fossil material taken from the upper Paleolithic site Kostenki 14, or Markina Gora.

Kostenki 14 site is located in Russia, on the central East European Plain, on the west bank of the Don River.

**Slide 4**

Kostenki 14 site was found in 1928 and is located in the Kostenki-Borshchevo district. It is situated in between the villages of Kostyonki and Borshchovo in Voronezh region (Praslov & Rogachev, 1982)

Currently, the Kostenki-Borshchevo area includes 26 Upper Paleolithic sites. It makes this area unique for research of the development and expansion of ancient human society (Sinitsyn, 2015b).

**Slide 5**

The multi-layer site Kostenki 14 attracts high attention because of the following reasons:

* It contains the largest number of cultural layers and the most detailed sequence of geological deposits. It has eight clearly stratified cultural layers and three bone-bed paleontological layers
* All cultural layers of this site contain rich collections of archaeological material
* There is a well a developed analytical base that includes:
  + - three pollen diagrams
    - a column of paleomagnetic variability
    - soil and geochemical analysis results
    - more than 80 radiocarbon and nearly 50 OSL-RSL datings (Sinitsyn, 2015a).

**Slide 6**

In addition to all of that, there is the oldest burial of an adult male of the modern anthropological type in Eastern Europe located under the third cultural layer.

The first phalanx of the middle finger of the right hand of the man was put in his mouth. The position of the skeleton and a number of violations of the anatomical order of the bones testify to the burial of this man in a bound state (Praslov & Rogachev, 1982; Sinitsyn, 2015a)

**Slide 7**

layer IVa has two reference horizons, one above and the other one below it. Above layer IVa, there is a layer of volcanic ash. Under the layer Iva, there is fossil soil with paleomagnetic reversal of the poles.

Thanks to these two reference horizons, the layer IVa has very reliable dating. Its age is determined as an interval between 39.1 to 41.0 thousand years. (Sinitsyn, 2015a; 2015b)

**Slide 8**

Fossil material used in our study was found in IVa layer. This layer has a lot of bones of *Equus ferus* (Sinitsyn, 2009). Collection of flintstone, found is this layer, is small and insufficient for its cultural attribution (Sinitsyn, 2015a).

**Slide 9**

About 4500 fragment of bones from this layer were studied within period of time from 1998 to 2012. Most of bone remains belongs to a wild horse. They represent at least 35 individuals (Burova & Petrova, 2011).

According to the number of horses, this site is unique in the East European Plain and is comparable to the world-famous site Solutre in France.

**Slide 10, 11**

These slides illustrate how many of what bones were found in this layer. Remains of horses are represented by all elements of the skeleton without exception.

All these bones has only rare teeth marks and a few cuts of flintstones on ribs.

Skulls are severely fragmented, the number of teeth corresponds to the standard number in the skull, and the isolated teeth lie, as a rule, in squares together with fragments of skulls.

Limb Bones and vertebrae are mainly not fragmented. The ribs, scapula and pelvic are all fragmented. There are anatomical groups of bones like parts of the vertebral column and distal limbs

The percentage of bone elements is indicated in %, their number is indicated in the circles (Burova & Petrova, 2011).

**Slide 12**

There are different points of view on the reasons for the formation of bone clusters in the VIa layer. Archaeologists and zooarchaeologists give different explanations.

**The point of view of archaeologists:**

* This layer is a kill-site where a herd of horses was killed and dressed by humans as a result of a one-time hunting

**The point of view of zooarchaeologists:**

* Bone accumulation in the layer was formed as the result of death of several herds of horses in different seasons. Zooarchaeologists allow two scenarios: natural death and human hunt. In the first scenario humans could also take parts of dead horses or even finish dying animals

So, we decided to make this study of dental cementum to obtain additional information about the season of death.

**Slide 13**

This is how the South Wall section of the site Kostenki-14 looked like in 2009.

**Slide 14, 15**

In our study, we used only permanent teeth: premolars and molars. In total, we studied 36 cheek teeth from 24 individuals. We made 82 thin sections and polished sections, and studied them in polarized, reflected and transmitted light.

**Slide 16**

**Methods:**

* **3D scanning.** Making thin sections and polished sections is a destructive method. In order to preserve the information about the samples as much as possible, we scanned all teeth in 3D with a 3D scanner before making samples.
* All teeth we cut and **thin sections and polished sections** were made.

**Slide 17, 18, 19, 20**

On those slides you can see several microphotos of the growth layers in dental cementum.

Blue dots and arrows on those image indicate winter elements of annual cementum layer or lines of arrested growth (LAGs). LAGs correspond to periods of slowed and arrested tissue growth. Between LAGs we see the growth zones. Growth zones are relatively thick layers of ‘‘summer’’ cementum growth.

Study of the last element of the main annual layer allows to determine the season of the animal's death.

**On slides 17, 18 and 19** a fully formed last growth zone can be seen. Its width is equal to or comparable with the width of the previous growth zones.

Active growth of summer cement is absent. So, the season of death can not be in the spring. **The season of death is autumn - winter**.

**On slide 20**, the last growth zone is not completely formed. Its width is smaller than the width of the previous summer elements. There is an active growth of summer cement. So, **the season of death is spring-summer**.

**Slide 21**

**Results**

* A study of dental cementum of *Equus ferus* from IVa cultural layer of the Upper Paleolithic site Kostenki-14 (Markina Gora) was done for the first time at this large-scale. Season of death was determined for 24 horses.
* Animals died in different seasons: spring-summer and autumn-winter. This is consistent with osteological data (on the time of eruption of teeth and stitching epiphyses and diaphises)
* The numbers of horses died in different seasons differ by more than 2 times:
* 17 horses died in the spring-summer period
* 7 horses died in autumn-winter period

**Slide 22**

On this slide, the results of our study represent in form of a diagram.

**Slide 23**

**Conclusions**

* IVa cultural layer is a territory where horses died in different seasons
* The numbers of horses died in different seasons differ by more than 2 times. It may be explained by both - particular selection of teeth and the nature of the real causes of the animal’s death. To find out the exact reason of their death, a further study is needed.

As an example, further study may also consider an idea that the death of horses in different seasons would happen during their seasonal migrations.

**Slide 24**

References

**Slide 25**

Aknowledgement

**Slide 26**

Thank you.