Paleoenvironmental conditions in early Pleistocene Romania: implications for hominin dispersals

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HOMININ DISPERSAL OUT OF AFRICA

- Theories for how and why hominins initially dispersed out of Africa typically fall into two categories:
  - Intrinsic hypotheses linked to characteristics of the organism such as new tool technologies, increased body or brain size, flexible behavior; or
  - Extrinsic (external) factors such as hominins following predator or prey migrations, demographic or environmental pressures, or mammalian dispersals
- However, many of these hypotheses are unsupported by evidence from the site of Dmanisi in the Republic of Georgia (e.g., Tappen 2009)
- At present, the best evidence is that climate fluctuations were a major influence on hominin dispersals out of Africa. Paleoclimatological studies demonstrate substantial changes during the early Pleistocene (e.g., Vrba 1995; Behrensmeyer et al. 1997) with an expansion of more open grassland biomes into Eurasia (e.g., Cerling 1991; de Menocal & Bloemendal 1995; Dennell & Roebroeks 2005)
- One outstanding possible intrinsic hypothesis that is not refuted by data from Dmanisi is that hominin dispersals were facilitated by increased behavioral flexibility (Potts 2012), which would have allowed hominins to exploit many types of habitats

HOMININ DISPERSAL INTO EUROPE

- The earliest well-dated European hominin site (Barranco León (Orce), Spain at 1.4 Ma) is over 400 thousand years younger than Dmanisi (~1.85 Ma) (Toro-Moyano et al. 2013)
- Were there geographic or environmental barriers that prevented or delayed hominin dispersal into Western Europe during the early Pleistocene?
  - Were there European carnivore species that outcompeted hominins for resources (Turner 1992, 1999)?
  - Or were there some ecologies to which hominins were unable to adapt (e.g., because of the lack of specific prey species or plant food items)?

Further data describing the range of habitats present in Eurasia during the early Pleistocene are necessary to fully evaluate the validity of these hypotheses. In particular, well-documented datasets from Eastern Europe, which likely served as a dispersal corridor into and out of Europe during the early Pleistocene, are critical. Only by further documenting paleoecological similarities or differences between sites in Eastern Europe and known hominin localities can we provide direct support for or against the hypothesis that these factors were important for preventing hominin dispersal into Europe.

Here we present preliminary paleoecological data from two early Pleistocene localities in Romania. The earlier of these two sites, Grăunceanu, is best attributed to the Late Villafranchian (MN17/MNQ1), making this site ~1.8 Ma. Copăceni, a slightly younger, smaller locality that is still actively producing fossils, has been preliminarily dated to ~1.2 Ma based on biostratigraphy. Together, these two sites bracket the interval during which hominins are thought to have first dispersed into Europe, and may therefore provide important clues regarding paleoenvironmental changes during this time.

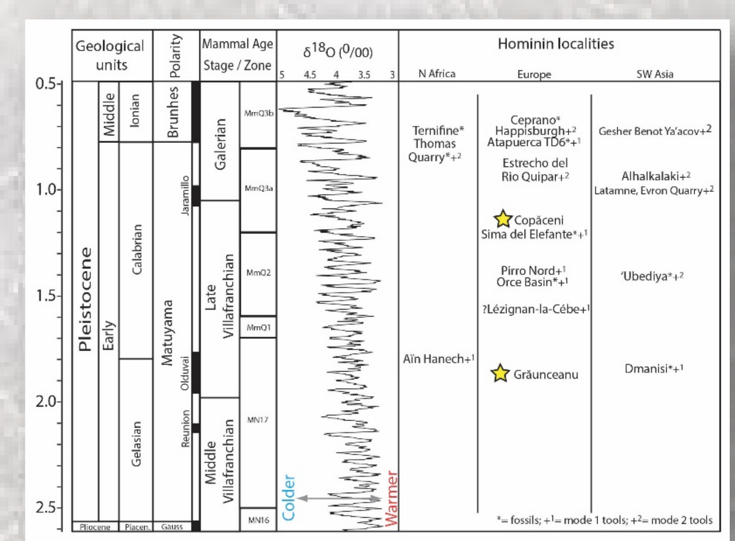
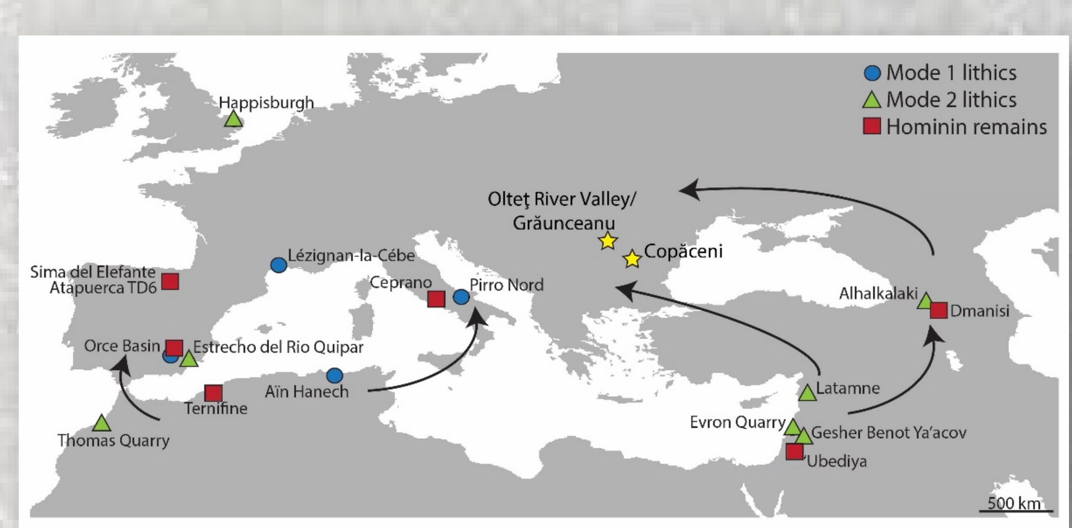


Chart showing geological units, polarity, land mammal ages, oxygen isotope data, and major hominin (or stone tool) localities in North Africa and Eurasia. Stars indicates the approximate time frames represented by the Olteț Valley Sites (i.e., Grăunceanu) and Copăceni.



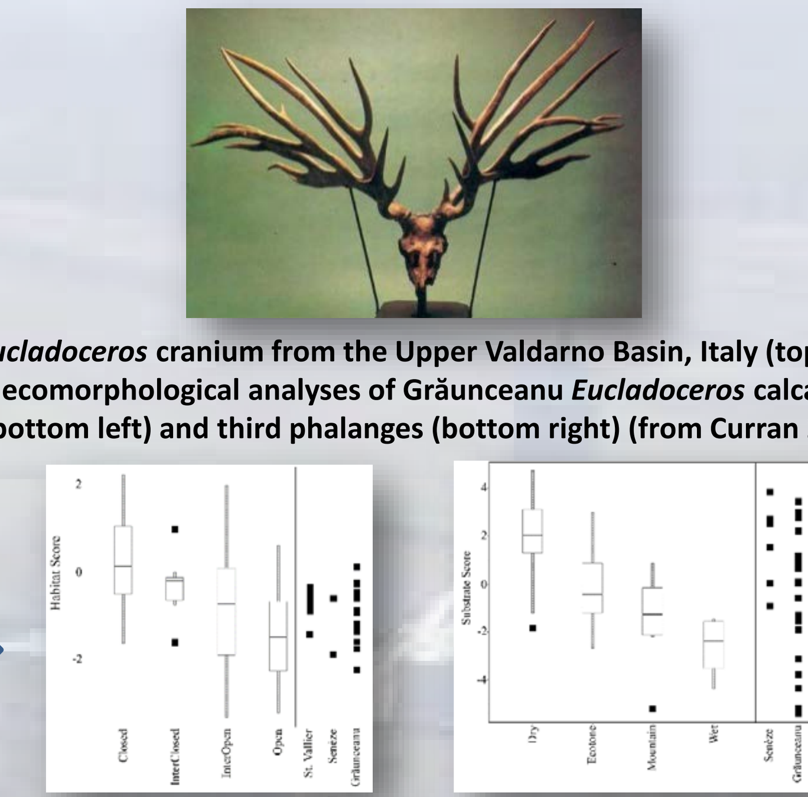
Map showing hominin localities in Europe, Southwest Asia, and North Africa during the early Pleistocene. Arrows indicate hypothesized dispersal routes into Europe. Stars indicates the Olteț River Valley (i.e., Grăunceanu) and Copăceni.

PALEOENVIRONMENTAL RECONSTRUCTION OF EARLY PLEISTOCENE ROMANIA

Grăunceanu and the Olteț River Valley Sites

- In addition to the highly fossiliferous site of Grăunceanu , as many as 15 smaller localities in the region have also yielded fossils
- 19 taxa identified during original investigations (Rădulesco et al. 2003)
- Grăunceanu reconstructed as open habitat with some tree cover situated near a river
- Faunal assemblage and reconstruction similar to that for Dmanisi, Georgia
- Best known for containing *Paradolichopithecus arvernensis*
  - Baboon-like primate that inhabited Eurasia during the Villafranchian (~3.5-1.1 Ma)
  - Dental wear patterns of *P. arvernensis* converge with *Australopithecus africanus*
  - Post-crania and large body size suggest *P. arvernensis* was highly terrestrial
- Calcaneal morphology of *Eucladoceros* suggest Grăunceanu cervids were adapted to open conditions; pedal morphology indicates adaptation to hard, dry ground with topographic relief (Curran 2015)

P. arvernensis from Grăunceanu



Eucladoceros cranium from the Upper Valdarno Basin, Italy (top) and ecomorphological analyses of Grăunceanu *Eucladoceros* calcanei (bottom left) and third phalanges (bottom right) (from Curran 2015)

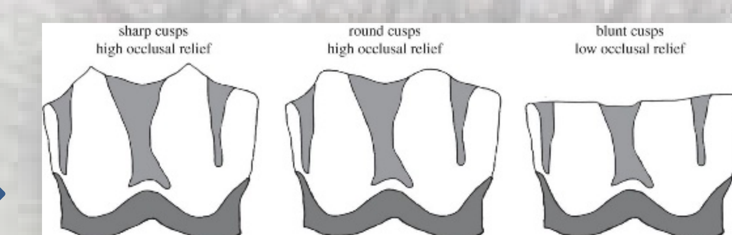
Copăceni

- Site situated along the banks of the Argeș River 20 km south of Bucharest
- Currently producing fossils; catalogued 118 specimens to date representing 16 taxa
- *In situ* fossils suggest little reworking, with a variety of specimens ranging from large mammals (proboscideans, rhinoceratids, cervids, bovids) to micromammals (rabbits, rodents, insectivores) recovered thus far

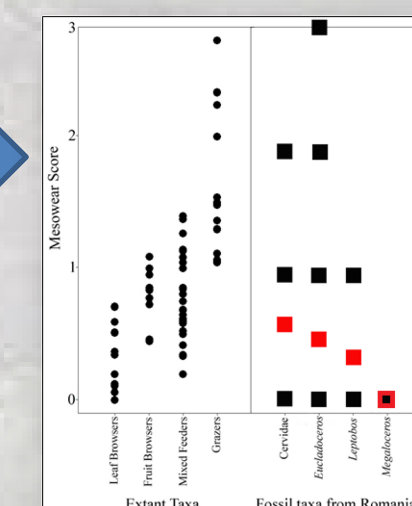
Copăceni site overview (left) and assorted fossils recovered from the site (right)

Mesowear

- *Megaloceros* and *Leptobos* (both from Copăceni) have mesowear patterns consistent with leaf browsing, while Cervidae (gen. + sp. unknown) and *Eucladoceros* sp. (from Grăunceanu) are more variable, and overlap somewhat with mixed feeders



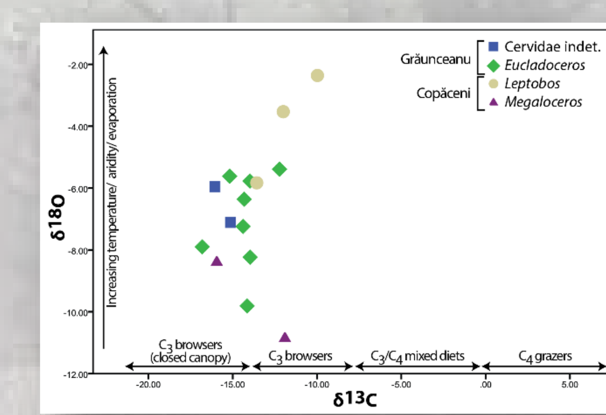
Mesowear scoring used here (cusp relief= high/low; cusp shape= sharp/round/blunt. Grazers tend to have low and flat cusps while browsers have high and sharp cusps (image from Louys et al. 2012).



Mesowear scores for extant Artiodactyla species of known diet (modern data from Fortelius et al. 2013, pers. comm.) and fossil specimens (means shown in red).

Enamel Isotopes

- Specimens analyzed from both Grăunceanu (Cervidae indet. and *Eucladoceros*) and Copaceni (*Megaloceros* and *Leptobos*) have relatively low $\delta^{13}C$ values, consistent with foraging in forested to closed environments
- Values of $\delta^{18}O$ are variable, with *Leptobos* appearing to be the most enriched species sampled, which may suggest feeding in more open areas. However, this contrasts with the carbon isotope signal for this species, which indicates feeding in closed environments



Scatter plot of $\delta^{13}C$ and $\delta^{18}O$ values. Fossil $\delta^{13}C$ values were shifted by -1.7‰ based on a mean estimated $\delta^{13}C$ value for early Pleistocene atmospheric CO_2 of -6.3‰ and modern $\delta^{13}C$ value of -8.0‰ (Passey et al. 2009).

Palynology

- Palynological analysis of two coprolites collected from Copăceni indicates that most botanical species from this site are associated with open and disturbed habitats

Coprolites recovered from Copăceni used in the palynological analysis.

Faunal lists from the early Pleistocene sites of Romania discussed here. *= taxonomic revisions made by our team; += taxa that will likely need to be revised due to updated species definitions. Taxonomic identification for Copăceni is in progress and thus many fewer taxa (than the OVR fauna) have been identified to date.

Olteț Valley Sites		Copăceni
Artiodactyla	Lagomorpha	Artiodactyla
Soergelia cf. *elisabethae*	*Hypolagus brachygnathus*	cf. Suidae
Bison cf. *schoetensacki*	Perissodactyla	*Leptobos etruscus*
Pliotragus ardeus	*Allohippus athanasiui+*	*Leptobos* cf. *furtivus*
Megalovis latifrons	*Allohippus tenonis mitilanensis+*	cf. *Leptobos* sp.
Leptobos sp.	*Allohippus* cf. *maxi+*	cf. Alcelaphini
Antilope sp.	*Allohippus* cf. *suessenbornensis+*	cf. Antilopini
Gazella sp.	*Allohippus* gr. *major+*	Bovini indet.
Antilopini indet.	*Equus aluticus*	*Megaloceros* sp.
Bovini indet.	*Equus* cf. *scythius*	cf. *Megaloceros*
Bovidae indet.	*Equus* sp.	Perissodactyla
Cervus nestii	cf. *Equus* sp.	*Equus* sp.
Eucladoceros sp.	*Dicerorhinus etruscus*	*Dicerorhinus etruscus*
cf. *Eucladoceros* sp.	cf. *Dicerorhinus* sp.	*Dicerorhinus* sp.
Allocaenelaphus sp.	Proboscidea	Proboscidea
Praealces gallicus+	*Mammuthus meridionalis*	*Mammuthus meridionalis*
Praealces cf. *carnutorum+*	Rodentia	Lagomorpha indet.
Cervidae indet.	*Trogontherium boisvilletti*	Carnivora indet.
Mitilanotherium inexpectatum	*Trogontherium dacicum*	Testudines indet.
Carnivora	*Hystrix refossa*	
cf. *Acinonyx**	*Castor plicidens*	
Lynx issiodorensis	*Castor* sp.*	
Homotherium crenatidens	Primates	
Megantereon megantereon	*Paradolichopithecus arvernensis*	
Felidae indet	*Paradolichopithecus geticus*	
Nyctereutes megamastoides	Testudines	
cf. *Nyctereutes*	*Geoemyda* cf. *mossoczyi**	
Canis etruscus	Insectivora	
Canis sp.	Beremendia cf. *fissidens*	
Canidae indet		
Meles sp.*		
Ursus etruscus		
Ursus sp.		
Hyaena perrieri		
Hyaena brevirostris		

Results of palynological analysis of two coprolites (one large and one small) from Copăceni. Most taxa indicate a relatively open habitat with disturbed soil.

	Lg Coprolite		Sm Coprolite		Habitat Indication
Taxon	n	%	n	%	
Pinus (pine)	1	0.5	0	0	well-drained, sandy soils
Betula (birch)	1	0.5	1	2.1	pioneer species, open floodplain, disturbed soil
Alnus (alder)	1	0.5	1	2.1	pioneer species, early succession, open lands
Corylus (hazel)	2	0.9	1	0	niche environments/understory, usually along forest edges
Ulmus (elm)	0	0	1	2.1	lowlands wet soils
Total Trees	**5**	**2.4**	**4**	**8.3**	
Poaceae (grass)	17	8	17	35.4	disturbed, open areas
Artemisia (wormwood)	14	6.7	4	8.3	early colonizing, disturbed soils, open areas
Asteroideae	14	6.7	4	8.3	disturbed, open grasslands
Cichorioidae	1	0.5	0	0	open, disturbed soils
Chenopodiaceae	132	63.1	12	25	disturbed soils, floodplains
Apiaceae	12	5.7	1	2.1	open, disturbed soils
Rosaceae	3	1.4	0	0	open to edge niches
Urticaceae	1	0.5	1	2.1	open areas, disturbed soils
Scrophulariaceae	2	0.95	0	0	temperate areas to tropical mountain areas
Cyperaceae	2	0.95	2	4.2	wet soils, disturbed to marshy environments
Indeterminate	5	2.4	3	6.2	
Spori trileti	1	0.5	0	0	
Total Herbs	**204**	**97.6**	**44**	**91.6**	
TOTAL	**209**	**100**	**48**	**100**	

SUMMARY AND CONCLUSIONS

These preliminary data suggest that artiodactyls at both Grăunceanu and Copăceni were foraging in relatively closed environments. These results are particularly interesting since ecomorphological analyses for *Eucladoceros* from Grăunceanu indicate open-habitat adaptations (Curran 2015); a mosaic morphological pattern for this taxon that has also been noted at other paleontological localities (Kaiser and Croiter, 2004; Valli 2004). Furthermore, the results of the palynological analyses suggest a relatively open habitat at Copăceni. Coupled with a continued re-inventory and analysis of the Grăunceanu remains and continued recovery and identification of fossil remains from Copăceni, these data have the potential to further shed light on paleoenvironmental conditions during this critical time period in hominin evolution.

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