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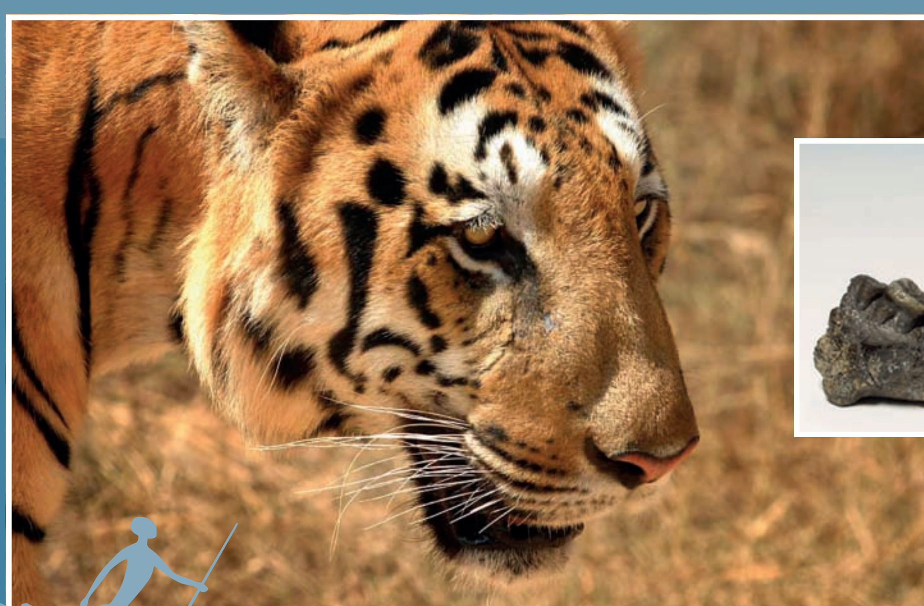
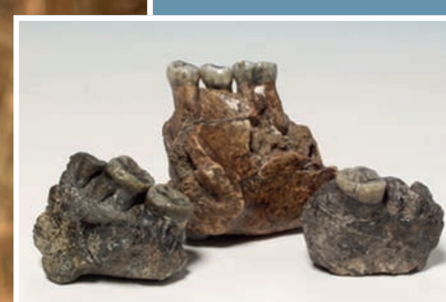
The Role of Culture in Early Expansions of Humans





Competitors on Pleistocene Java – tiger and *Homo erectus*

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THE ROLE OF CULTURE IN EARLY EXPANSIONS OF HUMANS

Editorial

The eight issue of the ROCEEH newsletter discusses competition between humans and carnivores on Java. It also presents the results of a study that examines what kinds of site locations three different forms of Neandertal preferred. Finally, we introduce a newly funded project in the Ethiopian Highlands which is affiliated with ROCEEH's activities.

Impact of Carnivores on Human Evolution: Competition between *Homo erectus* and Carnivores During the Pleistocene of Java

To study human expansions, we must first understand the environment in which humans lived and the role they played in it. Hominins competed with other animals for resources and were affected by their competitors, and an important resource for hominins was meat. According to studies by Aiello and her team, meat played an important role in human evolution because an increase in brain size was only possible by increasing the amount of meat in the diet of hominins. Carnivores likely had a high impact on human evolution and expansions because hominins must have interacted with their competition to find their role within the carnivoran guild structure. The ecological term 'guild' describes a group of species exploiting a common resource in a specific area. Therefore, omnivorous hominins are also included as part of the carnivoran guild. Still it remains unclear how resources are distributed within a guild and how this distribution affects individual guild members. The ROCEEH team developed a method to analyze the structure of carnivore guilds and the role of hominins within those guilds. Here we introduce this model with respect to Pleistocene carnivore guilds on Java.

Fragments of fossil mandibles of a tiger and a short-faced hyena (Kedung Prubus), as well as a Trinil dog (Sangiran). Tigers (top) are extinct on Java but still exist in Asia. Short-faced hyenas were widespread in Eurasia during the Pleistocene and were much larger than extant species such as the striped hyena (middle). Trinil dog is endemic during the Pleistocene of Java and was probably a pack hunting dog similar to African wild dogs (bottom).
(Photos: fossils – R. Volmer; living animals – J. Scholz.)

Homo erectus was a meat consuming hominin that inhabited Java about 1.5 million years ago. This species competed with several carnivores, especially the tiger. About 900,000 years ago the carnivore guild at the fossil site Trinil consisted of the tiger, *H. erectus*, the leopard cat and the Trinil dog. The tiger and the leopard cat are extant species and still occur in Indonesia and Asia. Trinil dog is an endemic species during the Pleistocene of Java, meaning it occurred only in this area and time period. About 100,000 years later a slightly different carnivoran guild existed in the location of Kedung Brubus about 20 km from Trinil. It consisted of the tiger and *H. erectus* as well. However, Trinil dog and the leopard cat are no longer present in the guild. Instead, the short-faced hyena and a giant otter became members of the carnivore guild. The two guilds at Trinil and Kedung Brubus are excellent examples for analyzing guild structure and discussing the different roles of *H. erectus* in carnivore guilds.

Trinil site at the Bengawan Solo river in Java where Dubois found the famous skull cap and femur of Homo erectus. (Foto: C. Hertler)

To analyze guild structure and the role of guild members we developed a model based on the theory of competition effects. In this model prey is considered as a limited resource. The guild depends on this resource and consumption of the resource by one guild member must affect other guild members. To calculate the effects of competition we developed the theory of competition free carrying capacity (CFCC). The ecological term 'carrying capacity' means the maximum population size of a specific species in a given habitat. The CFCC represents the population a guild member could reach if all other guild members were absent and it consumed all available prey mass on its own. In this regard, only prey categories relevant to the specific guild member are used. To calculate the CFCC we characterize the guild member by its actual population size, prey mass requirement and prey spectrum. The prey spectrum is very important, because not all prey items are an essential resource for each guild member. Thus the prey is characterized by its size and sorted into prey mass classes. The prey spectrum comprises the prey classes that a guild member hunts.

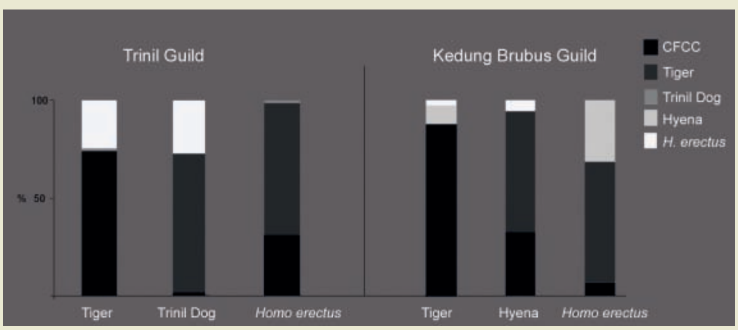
Next we calculated the CFCC for each guild member. Since the actual population size of each guild member is known, the loss of CFCC can be determined. The prey consumption of each guild member in each prey category allows the calculation of the capacity loss of one guild member to another. We call the percentage loss of CFCC of one guild member to another 'competition effect'.

We applied this model to analyze the guild structure of the Pleistocene carnivore guilds of Java. The role of each guild member is represented by the rank in the exploitation of its CFCC. The guild member that most exploits its carrying competition is ranked first and so on. To apply the model to fossil guilds we reconstructed the prey mass spectrum, meat requirement and population size. Instead of population sizes we used relative abundances based on NISP (number of identified specimens) in the fossil samples. Prey mass spectra of the carnivores and meat intake can be reconstructed by body mass and linear regressions. In the case of *H. erectus* we assumed an omnivorous diet comparable to living indigenous people and estimated protein and energy requirements based on physiological studies of humans today.

Analysis of the Pleistocene guilds reveals that the tiger dominated both guilds and had the strongest competition effect on *H. erectus* and other guild members. It ranks first in both guilds and maintains this position throughout the entire Pleistocene of Java. *H. erectus* plays different roles and suffers different competition effects in the Trinil and Kedung Brubus guilds. In Trinil *H. erectus* ranks second of the three guild members and exploits up to 31% of its CFCC. Its competition effect on other guild members is about 25%, comparable to the African lion in the Serengeti.

In the Kedung Brubus guild the second rank is occupied by the short-faced hyena. *H. erectus* slips down one place to third rank and exploits only 2% of its CFCC. In the Trinil guild the third position was occupied by the Trinil dog, which also exploited 2% of its CFCC. Thus *H. erectus* occupied different roles in the carnivoran guilds of Java, and its competition effect on other carnivores was slight to moderate. It suffered the strongest competition effect from the tiger. Interestingly, the Trinil dog became extinct after suffering high competition effects within the carnivore guild. Although *H. erectus* suffered the same competition effect in Kedung Brubus, it probably survived in Java until the arrival of *H. sapiens*.

Extinct Javan tiger (Photo: Andries Hoogerwerf 1938)



Competition effects in the Trinil and Kedung Brubus guilds showing the percentage exploitation of each guild members' CFCC (competition free carrying capacity) in black and the competition effects (percentage loss of CFCC to other guild-members) in grey and white.

H. erectus was omnivorous and probably more flexible than other hyper-carnivorous taxa like the Trinil dog. *H. erectus* likely relied on other resources in Kedung Brubus and may have survived thanks to its flexible diet. Since small carnivores are not known from Kedung Brubus, by shifting to smaller prey animals hominins would have avoided competition within the guild and increased the likelihood of their survival. Thus competition effects especially by the tiger demanded flexibility and adaptability by *H. erectus*. Competition by carnivores probably forced *H. erectus* to develop flexibility in exploiting food resources and shift its prey spectrum.

Rebekka Volmer

Explorative Spatial Analysis of Neandertal Sites Based on Stochastic Environmental Modeling

ROCEEH's fourth core hypothesis examines the Mediterranean region and asks if a 'uniform settlement of humans in a uniform ecospace is limited by cultural constraints?' To examine this question, we initiated a project entitled 'Physiographic characterization of landscapes favored by Neandertals–causes of the non-settlement of North Africa by Neandertals'. We conducted a study using a unique spatial dataset of all published sites with Neandertal fossils in Europe.

Based on the fossil evidence, the Neandertals were an indigenous European hominin form whose origins can be seen exclusively on this continent. They probably evolved from late forms of *H. heidelbergensis* or archaic *H. sapiens.* The first fossils with diagnostic Neandertal traits, and thus the Neandertal lineage, can be traced as far back as about 600,000 years ago. During the process of 'neandertalization' which can be described with the 'accretion model', more and more Neandertal traits accumulated until the Classic Neandertals appeared during the last Glacial period. Based on this model, we classified the fossils examined in our study into three categories:

1. **Pre-Neandertals** are fossils of *H. heidelbergensis* or archaic *H. sapiens* which show the first distinct Neandertal features. While they are not Neandertals themselves, they stand at the threshold of what might be referred to as Neandertals.

2. **Early Neandertals** appear around 250,000 years ago and can clearly be distinguished from *H. heidelbergensis*. We use this term for all pre-Weichselian/Wurmian Neandertal fossils.

3. **Classic Neandertals** appear starting with the last Glacial some 115,000 years ago. Fossils of Classic Neandertals are spread over larger parts of Europe and can also be found in the Near East, in the western part of central Asia, and even in the Siberian Altai region.

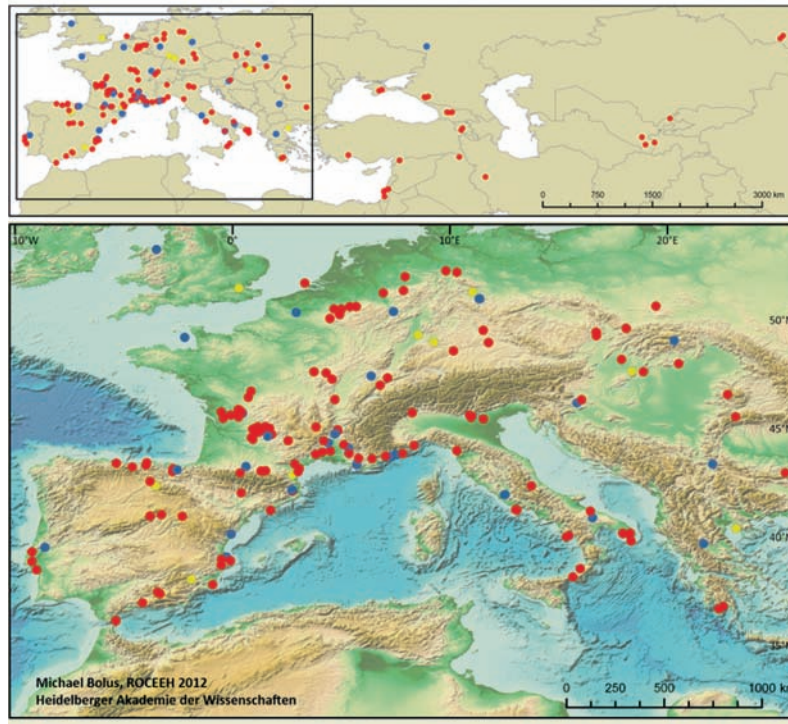
Since we only examine European sites in this study, it suffices to equate the time of the Neandertals with the Middle Paleolithic period which started around 300,000 years ago and lasted until about 30,000 years ago. Neandertals produced a broad variety of stone tools including handaxes and other bifacial tools, different types of side-scrapers, variable point types, and many others. Formal organic tools are very rare. While the use of pigments can be traced backed to Early Neandertals, personal ornaments are restricted to a small number of late Neandertal sites. Neandertal burials may give insight into the spiritual world of the Neandertals.

Our study includes 219 sites from 29 countries, including 11 sites with Pre-Neandertals, 34 sites with Early Neandertals, and 174 sites with Classic Neandertals. The inset map shows these sites and highlights the core area of Neandertals in southern and southwestern Europe. Given this ecospace, Neandertals originally were adapted to a temperate, rather than cold or even extremely cold climate. However, under favorable climatic and environmental conditions, they repeatedly expanded their ecospace, moved into areas of temporary occurrence and even ‘learned’ to cope with harsher environmental and climatic conditions. During the last Glacial, Classic Neandertals enlarged their originally exclusive European settlement area, expanding into the Near East, parts of Central Asia, and even as far as the Altai region. This dispersal has been called the *‘Out of Europe Movement’* by J. Serangeli and M. Bolus.

We aim to test the hypothesis that expansion corridors and settlement sites were controlled by environmentally driven factors, rather than by aspects of culture. Hence, by analyzing known locations of settlement of Early and Classic Neandertals with regard to environmental factors, we may be able to decipher the specific preferences of site locations for these two Neandertal types. Moreover, we can use this knowledge to explore potential site locations on broader spatial scales. Our approach is based on the following assumptions:

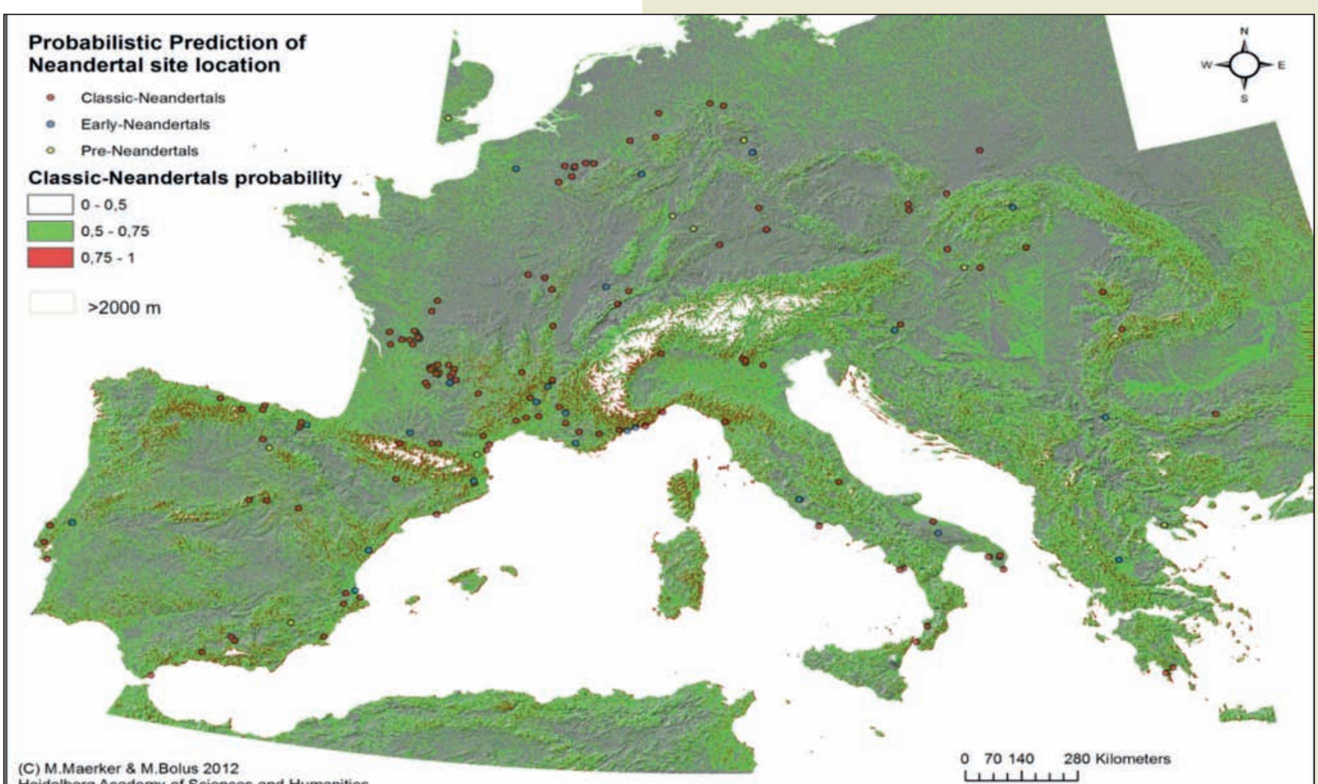
a) Different environmental proxies describing hydrology, geomorphology, vegetation, soils and climate, as well as strategic issues, can be derived from the topography. Moreover, information about the related process dynamics can also be deduced from topography.

b) Topography is conservative, meaning that present day topography reflects elements and processes of paleo-landscapes.



Distribution of Pre-Neandertal (yellow dots),
Early Neandertal (blue dots),
and Classic Neandertal (red dots) fossils.

Probabilistic prediction of Classic
Neandertal site locations.



Consequently, present day topography can be utilized to detect relations between site locations and their environmental surrounding. In order to assess the relations between the Neandertal sites and environmental variables, we applied a boosted regression tree approach according to Friedman.

Information on topographic locations and the characteristics of these locations were collected based on our own work and a comprehensive literature review. Subsequently, the coordinates were post-processed to guarantee topographic accuracy and converted to a vector point format. The find locations were then utilized to study the local characteristics around these locations in detail. We performed a terrain analysis on SRTM 90 m DEM (Digital Elevation Model) which was subsequently reassembled to 250 m to reflect the local topographic conditions in at least a 6.25 ha surrounding. In total we delineated 46 topographic indices and used the site information to assess the specific combinations at the find locations. To reveal the importance of single indices and site specific index combinations, we applied a boosted regression tree approach.

The study illustrates that Pre-Neandertals, Early Neandertals and Classic Neandertals not only show specific spatial distributions, but are also characterized by different environmental preferences. Early Neandertals show mainly a climatic dependency, whereas Classic Neandertals are characterized by a more specific site selection that takes into account strategic aspects, as well as water availability. Internal model validation shows outstanding results. However, the results were also validated using find location maps.

Moreover, the methodology allows for a spatial prognosis of occurrence probabilities for Neandertal sites, as shown in the spatial prediction of Classic Neandertal sites. It is interesting to note the generally high potential modeled for Northern Africa. Even though Neandertals have not yet been reported from Northern Africa, it seems that there are areas suitable for Classic Neandertal sites based on the inferred typical site characteristics. Thus aspects of culture may play a role in the lack of Neandertals in Africa, since anatomically modern humans lived in northern Africa at the same time in an ecospace quite similar to that of the Neandertals in the northern Mediterranean region.

In the next project phase we will try to incorporate further boundary conditions such as ice shield expansions and mountain glaciers. Moreover, we will try to differentiate Classic Neandertals within narrower time slices.

Michael Märker and Michael Bolus

Integrated Assessment of Geomorphological Process Dynamics on Different Spatio-temporal Scales in the Ethiopian Highlands Using Remote Sensing and Advanced Modeling Approaches

A new bilateral project financed by the German (DFG) and Czech (GACR) Science Foundations focuses on the integrated assessment of geomorphological process dynamics at different spatio-temporal scales in the Ethiopian Highlands using remote sensing and advanced modeling approaches. The overall objective of the project is to assess present day geomorphic processes and analyze the complex system of the Ethiopian Highlands in terms of its erosion sensitivity and landscape evolution. The project provides a comprehensive method assessing erosion and mass wasting features using new multi-sensor, high resolution, remote sensing systems applicable in remote and data-scarce regions. Moreover, advanced physically based modeling methods will be applied to analyze the systems dynamics and assess landscape evolution. The test site at the contact zone of the Ethiopian Plateau with the African Rift Valley shows various symptoms of land degradation due not only to rapid changes in land cover related to growing population pressure in

Erosion in the Ethiopian Highlands (Photo: M. Märker)

the last decades, but also high geomorphologic dynamics. Therefore, geomorphological field methods will be combined with the evaluation of advanced high resolution remote sensing data and new generations of digital elevation models forming an integrated approach to assessing mass wasting and soil erosion. The time series data (CORONA) date back to the mid 1960s and will be extended by current information on process relevant characteristics, such as surface roughness, soil exposure, slope movement, vegetation disturbance and soil specific components including mineral composition and organic content. All of this information will act as an area-wide input into distributed models. Finally, the project will focus on the development of an integrated soil erosion and mass wasting assessment method with innovative physically based models and a non linear 'graph theory' approach in order to understand the system's sensitivities and eventually the landscape evolution processes. The latter ones are a prerequisite to understand human impacts already in prehistory. The project started in Oct. 2012, will run for three years and comes with one post-doc and one Ph.D. position.

Volker Hochschild, Michael Märker, Vít Vilímek & Jiri Zvelebil

Forthcoming

- Conference: 4th East African Association for Palaeoanthropology and Palaeontology (EAAPP) Conference **(28 July – 1 August 2013)** in Mombasa, Kenya. Co-sponsored by ROCEEH. (http://www.eaapp.or.ke/events.htm)
- Conference: 8th IAG International Conference on Geomorphology **(27–31 August 2013)** in Paris, France. (http://www.geomorphology-iag-paris2013.com/)
- Workshop: Arbeitskreis Fernerkundung **(26–27 September 2013)** in Tübingen, Germany by Prof. Dr. Volker Hochschild. (http://www.geo.uni-tuebingen.de/forschung/ak-fernerkundung-2013.html)
- Workshop: The role of the Southern Caucasus on early human evolution and expansion – refuge, hub or source area? **(15–20 October 2013)** in Tbilisi, Georgia by Angela A. Bruch and David Lordkipanidze. Jointly organized by ROCEEH, the Project 'Early Pleistocene Environmental Changes in Southern Caucasus' funded by the Volkswagen Foundation, and the National Museum of Georgia in Tbilisi.

Who's who?

This issue:
Zara Kanaeva

Zara Kanaeva

Zara Kanaeva is a programmer and computer science specialist in the ROCEEH project. She studied Computer Science at the University of Marburg and at the Free University of Berlin. Her interests and specialization were theory of computer languages, computer linguistics and databases. Her primary professional focus areas today are databases, geoinformatics (PostGIS applications, web map services) and WEB programming (PHP, JavaScript). For the ROCEEH project she developed the ROCEEH database (ROAD), programmed several web-based components of the graphical user interface (GUI), and brought together diverse free software packets to create the effective appearance of the ROCEEH project on the web. Besides her programming and technical activity, she is interested in applications of bioinformatics in archaeological research and applications of mathematics in geoinformatics.

References of figures on front page:
a) Tiger (Steve Evans http://flickr.com/photos/64749744@N00/343570800)
b) Homo erectus fossils from Sangiran (Senckenberg Research Institute)

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