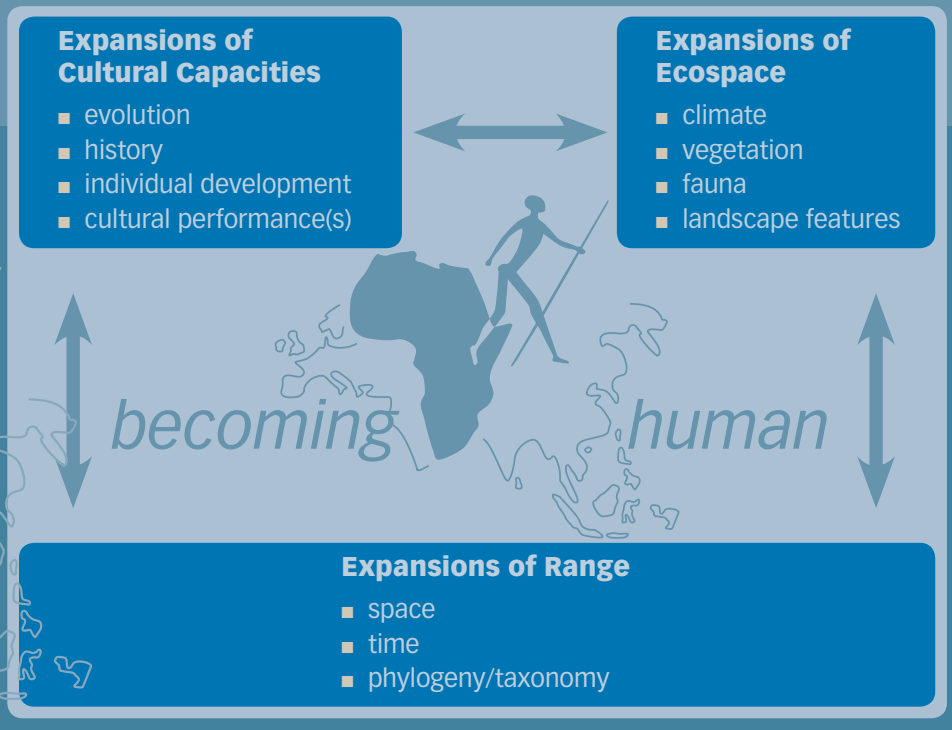
newsletter 5 | 2011

The Role of Culture in Early Expansions of Humans



The three dimensions of expansion

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THE ROLE OF CULTURE IN EARLY EXPANSIONS OF HUMANS

Editorial

With this fifth issue of the ROCEEH newsletter, we present insight into some of the theoretical issues that touch upon our research. The first section focuses on three meanings of the term "expansion". This issue introduces methods of sophisticated geostatistical analysis, such as stochastic gradient boosting (TreeNet), and presents an update on our fieldwork in Armenia. Finally, we report on the ROCEEH symposium "The Nature of Culture".

Dimensions of Expansion

ROCEEH observes, studies and attempts to explain the patterns of hominin expansion. However, the term expansion refers to various phenomena that are relevant to ROCEEH. Here we provide three definitions of expansion, discuss the links among them, and sketch out methodological considerations. First, expansion characterizes the basic phenomenon of spatial range extension (positive expansion), range shift (neutral expansion) or range contraction (negative expansion). In this basic sense, this concept of expansion is frequently applied in paleobiogeographical studies. The spatio-temporal distribution of both hominin fossils and artifacts provides us with an empirical body of data on which to base the reconstruction of distribution patterns and their changes over the course of time, in other words, dispersals. Such data are collected and stored in the ROAD database.

However, ROCEEH's efforts do not stop here. Additionally we aim to explore cultural and natural determinants of range expansion (see diagram on front page). We understand hominin distribution and dispersals as essentially determined by environment, ecology and behavior.

By employing the concept of cultural capacities, ROCEEH characterizes the biological, historical-social, and individual dimensions of cultural behavior and its evolution. Cultural capacities increase in human evolution allowing cultural performances to become increasingly flexible and diversified. We understand these processes as a second kind of expansion event. These changes enable hominins to intensify the occupation of already inhabited spaces, or to occupy spaces not inhabited at earlier stages, and are thus related to an increase in adaptivity. However, hominin distribution is limited by resource access and the presence of competitors. The spectrum of available resources and biotic conditions in the environment is

Representing different cultural capacities: A Middle Pleistocene artifact held by a human equipped with modern material culture (Photo: A. Gonschior).

characterized as hominin ecospace. A third dimension of expansion examines changes in environments that were inhabited by hominins. Expansions of ecospace are related to concepts such as environmental and ecological variability.

The general outline of expansion concepts in ROCEEH suggests three general working hypotheses:

- Hominin range expansions are processes determined by either behavioral and cultural capacities or ecology, environment and ecospace.
- Cultural capacities increase and cultural performances diversify over the course of human evolution and (co-)determine dispersal potentials at any stage of the range expansion process.
- Spatial distribution patterns of resources are described as hominin ecospaces. Such a concept of ecospace identifies an area that hominins may have inhabited. Hominin ecospaces are specific at any stage of the process and expand during the course of human evolution along with progressively flexible strategies of landuse.

However, these three dimensions of expansion are interrelated and cannot be considered independently. In this issue we focus on expansions of range, because this dimension empirically unites all individual ROCEEH related questions. Our concepts about expansion of cultural capacities and of ecospace will be introduced in future issues.

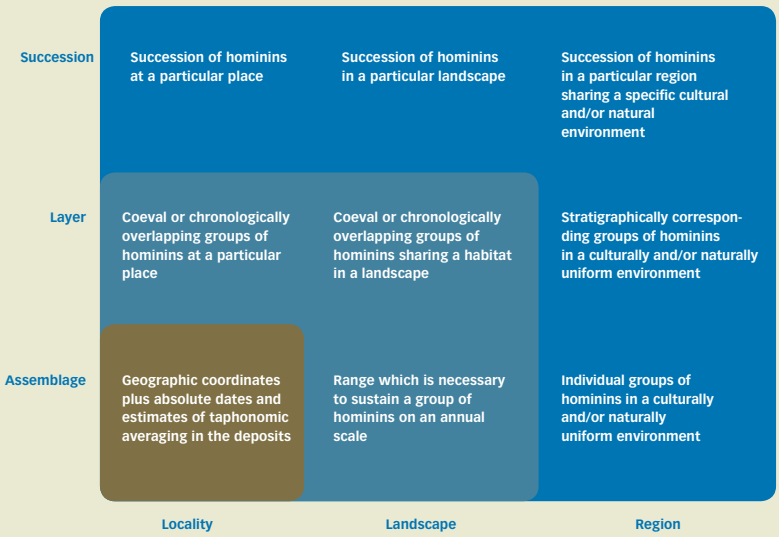
The concept of range expansions links three empirical parameters in order to infer expansions of (1) geographical range from fossil hominins (phylogeny/taxonomy), (2) their geographical position (space) and (3) their age (time). Identifications of hominin specimens are notoriously contested. A large part of paleoanthropological discussion focuses on species attributions and the consequences of these identifications. From a methodological viewpoint this can be explained by the varying concepts of species in use. Different ways of classifying species result in different determinations, even though they may generate overlapping groups. Since ROCEEH wishes neither to select nor rate specific phylogenies, we developed a hominin scenario tool in the ROAD database. The scenario tool permits us to variously identify key hominin specimens in order to test or compare specific scenarios and their paleogeographical consequences. These scenarios are derived either from publications or represent the deliberations of experts who wish to test an unpublished scenario.

Hominin ecospace is limited by resources and competitors (Photo: S. Engels).

The two other variables affecting a scenario are space and time, and these must be critically examined as well. Their precision depends on the targeted scale of a specific study. At the simplest level, local coordinates of sites and localities are available. The specific taphonomy of a site and related transport processes involved in its formation may cause various degrees of spatial averaging. The spatial range that has to be considered to account for taphonomic processes depends on the transport mechanisms involved and the respective properties of the main fossil and artifact groups. These factors constrain the degree to which spatial resolution can be achieved. Radiometric dating, on the other hand, provides a precise chronometric age for an assemblage, but the accuracy depends on the dating method applied, the material available for dating and the exact location of the site. As is the case with spatial averaging, chronological averaging plays a role in the temporal resolution. Some assemblages incorporate chronological averaging that varies depending on the type of assemblage, for instance, whether it includes archaeological finds, pollen from profiles, or vertebrate fauna including hominids. In order to deal with differential spatial and temporal scaling of assemblages, ROCEEH developed a model that allows the attribution of a sample to a particular scale of resolution. Since hominids constitute our main focus, we adjusted our scale to resolve hominids and their activities.

Where transport processes result in spatial averaging, the lowest resolution may expand from the level of the *locality* to that of the *landscape*. By landscape we mean a space in the environment used by a hominid group. A *region* corresponds to the next level of spatial integration and represents natural or cultural areas with uniform environmental conditions.

Likewise, specimens retrieved from stratigraphically corresponding levels represent coeval groups of hominins. Chronological resolution for such groups, however, is less precise than the one retrieved from an individual *assemblage*. As a result, the datasets are located on a different chronological level, namely the *layer*. A layer delineates a distinct phase in time. Summarizing different layers permits the analysis of a succession of hominins and the comparison of different ages in order to reconstruct a *sequence*. These levels of integration are referred to frequently and play a major role in the hominin scenario tool.



Scaling model plotting the geographical extent (space) on the x-axis versus the geological extent (time) on the y-axis. Terms are clarified in bold within the text.

With the scenario tool and the scaling model we introduce a basic set of tools to support joint efforts and encourage scientific discussions of various models for hominin range expansions. Now we apply both to a variety of research questions that will help clarify some of the contested issues.

Christine Hertler & Miriam Haidle

Eco-space and cultural development of early humans in the Southern Caucasus

At about 1.8 million years ago, the first human species to leave Africa appeared in the region south of the Caucasus. This event is documented by the oldest archaeological and paleoanthropological materials found in Eurasia at the site of Dmanisi in Georgia. ROCEEH's research aims to understand local environments of the Early Pleistocene as prerequisites for the first appearance of hominins outside of Africa. The studies also focus on the ecological and cultural development of the various human groups that inhabited the Southern Caucasus throughout the Pleistocene.

Early Pleistocene vegetation and climate reconstructions are primarily based on plant fossils and examine the time between one and two million years ago when early humans first inhabited the region. By comparing short-term changes in vegetation resulting from different climatic events and in various regions, it will be possible to understand the mechanisms of climatic influence on local vegetation, translate the global climatic signal to a local scale, and extrapolate it onto periods that lack a fossil record. Especially in the Southern Caucasus with its considerable topographic relief, it is crucial to understand altitudinal and spatial differentiation of vegetation units and how they shift as climate changes. Therefore, three regions were chosen for comparison and correlation: the Southern Armenian highland, the Southern Georgian highland, and the Western Georgian lowland.

The vegetation and climate data obtained from plant fossils will be linked to other available environmental information based on mammals, insects, geology and geography to create a comprehensive landscape reconstruction using GIS analyses to provide a spatial interpretation of the data. Based on these results we aim to identify temporal and spatial corridors of landscape in the Southern Caucasus which were appropriate for the presence of early humans during the Early Pleistocene.

In addition to these regional ecological studies, our activities also include the assessment of the cultural development of early humans in Armenia. While archaeological evidence exists documenting the presence of early hominin

Aghitu-3 Cave. Overview of excavation in archaeological layer VI at the base of the north profile. (Photo: A. Kandel).

A fossil leaf of Acer iberica (Photo: A. Bruch).

species, the oldest evidence for modern humans, Homo sapiens, comes from an Upper Paleolithic sequence of the Vorotan Basin in the south. The ongoing excavations at Aghitu-3 Cave and the analysis of archaeological materials from other Upper Paleolithic sites in Armenia will shed light on the lifeways of the earliest modern humans in the Southern Caucasus. Data on subsistence strategies of these people and the local environment in which they lived will be derived from archaeozoological and archaeobotanical material collected from these sites. In parallel, pollen and macrobotanical analyses from natural archives will provide independent environmental information on climate and vegetation development. Angela Bruch & Andrew Kandel

Depositional Processes and Site Prediction in the Lake Manyara Area, Northern Tanzania

The area of Lake Manyara and the Makuyuni River Basin, Northern Tanzania is known for its Middle Pleistocene fossils and artifacts. Two fossil bearing layers occur near the boundary between the Lower and Upper Manyara Beds. The upper beds are dated to the Middle Pleistocene by correlation with the Olduvai sequence. The lower lacustrine and the upper terrestrial deposits are separated by a boundary characterized by a color change reflected in grayish lacustrine sediments grading upwards into reddish terrestrial deposits. The entire stratigraphy is interspersed with reworked tuff deposits.

The large number of localities containing fossil vertebrates and artifacts detected during previous field campaigns were the reason for a more in depth analysis of the spatial distribution of these sites in relation to present day environmental characteristics and processes. Therefore, we developed an integrative spatial modeling concept using GIS, remote sensing and sophisticated statistical methodologies. The approach takes into account a variety of environmental data such as topography, spectral satellite information, field observations and stratigraphic characteristics.

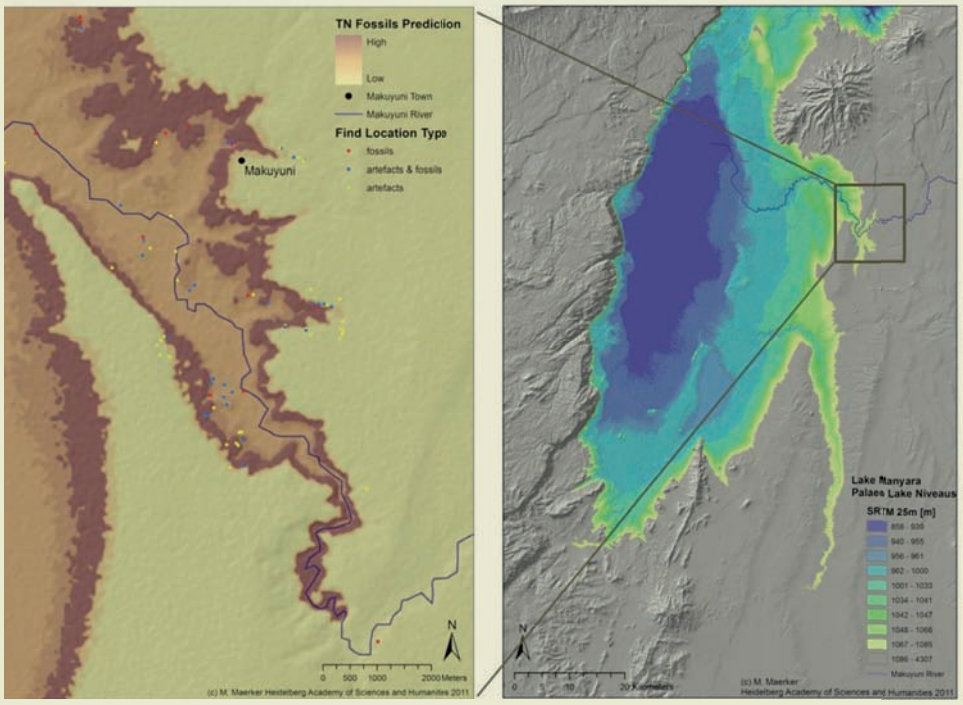
To analyze the spatial distribution of potential paleontological localities and related environmental processes, we applied a sophisticated classification and regression tree method known as boosted regression trees or stochastic gradient boosting (TreeNet, Salford Systems). This approach yields detailed information about the relative variable importance and thus, gives information about the corresponding geological processes for classified paleontological sites.

The tables showing the relative variable importance produced by TreeNet illustrate the significance of the curvature classification for localities with fossils and artifacts. This parameter describes terrain elements with dissipation or accumulation characteristics and serves as a proxy for ero-

Variable	Fossils
CURVATURE_CLASSIFICATION	100,00
PRO_ASTE4_TIF	33,88
PRO_ASTE3_TIF	31,26
CONVERGENCE_INDEX	29,68
FILLED_DEM_SGRD	25,97
PROFILE_CURVATURE	22,48
ASPECT	22,21
NDVI_TIF	22,18
PLAN_CURVATURE	22,13
PRO_ASTE2_TIF	19,64
STREAM_POWER	19,63
CHANNEL_NETWORK_BASE_LEVEL	17,75
CATCHMENT_AREA	15,55
LS_FACTOR	13,28
ALT_ABOVE_CHANNEL_NETWORK	12,87
PRO_ASTE1A_TIF	7,99
SLOPE	7,19
WETNESS_INDEX	4,45
CURVATURE	1,09
CHANNEL_NETWORK	0,00

Variable	Artefacts
CURVATURE_CLASSIFICATION	100,00
STREAM_POWER	47,07
WETNESS_INDEX	45,30
PRO_ASTE4_TIF	42,04
PROFILE_CURVATURE	38,87
PRO_ASTE2_TIF	35,86
CURVATURE	28,85
PRO_ASTE3_TIF	27,91
SLOPE	27,63
LS_FACTOR	26,72
CATCHMENT_AREA	26,48
FILLED_DEM_SGRD	26,13
PRO_ASTE1A_TIF	25,19
PLAN_CURVATURE	24,16
NDVI_TIF	23,58
CHANNEL_NETWORK_BASE_LEVEL	21,99
ASPECT	21,45
CONVERGENCE_INDEX	20,83
ALTI_ABOVE_CHANNEL_NETWORK	18,64
CHANNEL_NETWORK	0,00

Variable importance for the fossil sites (above) and the artifact sites (below).



Regionalization of the TreeNet results for the fossil sites. Dark brown indicates high probability of a fossil site; beige, low probability.

sional and depositional processes, respectively. However, the second and third parameters differ between fossil and artifact bearing sites and characterize find-specific processes with regard to the types of sites. In the case of fossil sites, the next parameters are the ASTER spectral bands 4 and 3 which identify the color differences between Lower and Upper Manyara Beds and reflect the impact of stratigraphy. This corresponds well with the known stratigraphic distribution of fossils. This trend is robust with regard to the taphonomic processes of deposition which differ between the Lower and Upper Manyara Beds.

The findings from the fossil sites are also mirrored by the prediction of site probabilities. The highest probabilities for a fossil site are highlighted in red and follow the boundary between the Lower and Upper Manyara Beds. Moreover, the highest probabilities correlate spatially with the former lake shoreline. The relative variable importance of the artifact category reveals two parameters that are mainly related to water flow and erosional processes, namely the stream power index and the wetness index. These two factors indicate the influence of runoff processes on deposition.

Thus, these analyses yield a new hypothesis concerning the processes related to the localities and find classes: artifacts seem to be mainly transported by water, whereas fossils correlate with the stratigraphy and are not transported in a similar way. These hypotheses need further investigation and will be the focus of the next field stage in Tanzania.

Michael Märker

ROCEEH Symposium

"The Nature of Culture"

Tübingen, 15-18 June 2011.

The aim of an international conference organized by ROCEEH was to introduce and discuss in detail both a proposal for a concept of culture and a model of the course of cultural evolution. The symposium was supported by the *Deutsche Forschungsgemeinschaft* (DFG) and held at the Hohentübingen Castle from 15 to 18 June 2011. Primatologists, Paleolithic archaeologists, paleoanthropologists, and cultural anthropologists enhanced the interdisciplinary dialogue. The basis of discussion was the proposal of the concept of culture and the model of the expansion of cultural capacities with invited papers referring to selected parts of the proposal. Summary blocks for each proposed stage of the model allowed room for debate, as well as a mid-conference excursion to cave sites in the Ach valley and to the *Urgeschichtliches Museum Blaubeuren*. An intense round of closing discussion brought together the different preliminary statements, disciplinary views, intermediate summaries, and suggestions for improvement. The results were an integrative concept of cultural capacity, cultural performance, and the evolutionary processes involved.

A modified model of the expansion of cultural capacity was widely agreed upon. In all, six steps of expansion were identified including achievements from previous models. The first three steps – capacities for socially transmitted information, capacities for tradition, and basic cultural capacities – are also observed in some animal species today. The participants agreed that a focus on the archaeological record, instead of ethologically derived features that are difficult to trace archaeologically,

would be more expedient. Three further steps with their basis in cognitive extensions were identified in human evolution:

- modular cultural capacities, based on the ability to produce tools with other tools,
- composite cultural capacities, based on the ability to combine different objects into single tool units, and
- collective cultural capacities, based on the ability to perceive a group (agents, objects, persons, things) as an acting entity of interdependent parts.

The discussion is summarized in the *Mitteilungen der Gesellschaft für Urgeschichte* 20 (2011). Miriam Haidle

International and interdisciplinary visit at the Hohle Fels excavation during the symposium "The Nature of Culture", 17 June 2011 (Photo: R. Stolarczyk).

Forthcoming

- Symposium: "Excavations at Schöningen and new insights into Middle Pleistocene adaptations in northern Europe" by Nicholas J. Conard and Christopher E. Miller. 77th Annual Meeting of the Society for American Archaeology **(18–22 April 2012)** in Memphis, Tennessee (USA). (http://www.saa. org/aboutthesociety/annualmeeting/tabid/138/default.aspx)
- Workshop: "Environmental Background of Early Hominin Dispersal in Western Eurasia" by Christine Hertler and Ralf-Dietrich Kahlke in collaboration with the Human Environmental Programm HEP held **19–20 April 2012** at the Senckenberg Research Station for Quaternary Paleontology, Weimar.
- Joint ROCEEH and NECLIME Symposium: "Quantifying Cenozoic vegetation? New developments in standardized approaches" by Angela Bruch and Elena Vasio and joint ROCEEH and NECLIME Symposium: "Into the Icehouse? Climate and vegetation change from the Pliocene to early Pleistocene" by Torsten Utescher and Angela Bruch. 13th International Palynological Congress/ 9th International Organisation of Palaeobotany Conference **(23–30 August 2012)** in Tokyo (Japan). (http://wwwsoc.nii.ac.jp/psj3/en/index.htm)

Who's who?

This issue: Angela Bruch

Angela Bruch in the field in Armenia.

Dr. Angela A. Bruch is ROCEEH's paleobotanist at the Senckenberg Research Institute in Frankfurt am Main. Her research focuses on the quantitative reconstruction of terrestrial paleoenvironments, including climate quantification based on plant fossils. After her diploma in geology and paleontology at Kiel University she finished her dissertation on Tertiary palynology and climate development in the Eastern Alpine region at the Faculty of Geosciences at the Eberhard Karls Tübingen University in 1998. During the last decade she contributed to the reconstruction of Neogene environments in Eurasia with spatial and temporal analyses of paleoclimate data from various regions and times. Her habilitation with the title "The Miocene Climate of Europe–quantitative climate reconstructions based on plant fossils" was accepted by the Faculty of Sciences at Eberhard Karls Tübingen University in 2011. Her current research focuses on understanding the differences in the reaction of terrestrial ecosystems to Pleistocene global climatic changes. Her numerous and active international collaborations aim to quantify climate and vegetation and compare regional environmental systems in places as varied as Africa, China, Europe, and Southwest Asia.

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