ABSTRACTS BOOK

4th Meeting of the ICAZ Microvertebrate Working Group

September 8th – 10th 2022

Tübingen (Germany)

The Microvertebrate Working Group (MVWG) was developed in 2016 as a forum for the exchange of data and information related to the study of insectivore, rodent, bat, reptile and amphibian remains from archaeological deposits. These studies are published in various mediums including international journals, regional bulletins, museum archival reports, monographs and technical papers, which often cross time periods and geographic regions. The overarching goal of the MVWG is to provide a platform for the exchange of this scientific literature and to increase communication between academics, professionals, and, in particular, graduate students with research interests related to microvertebrates. Group interests include, but are not limited to, taxonomic identification and evolution, biostratigraphy, palaeoenvironment reconstruction, commensalism, taphonomy, and studies of related methodology, scientific techniques and theory. In addition to regular working group meetings, where research will be presented via thematic workshops, the MVWG will also provide information about the most recent published literature from this field via a biannual electronic newsletter.

https://mvwgicaz.wixsite.com/mvwg

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Microvertebrate Working Group

Senckenberg Centre of Human Evolution and Palaeoenvironment - University of Tübingen

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Content

DETAILED PROGRAM

THURSDAY 8th September 2022

09:30 Reception and opening of the meeting

10:00 Welcome by our hosts and the head of the Department of Early Prehistory and Quaternary Ecology, Dr. Nicholas J. Conard

Session 1 – MICROVERTEBRATES 2.0 – NEW AND IMPROVED METHODS (10:30 – 12:50)

Moderate by: Dr. Sara E. Rhodes

10:30 – 10:50
Understanding the morphological variability, the example of north American Collared Lemming (*Dicrostonyx* sp.)
Louis ARBEZ, Aurélien ROYER, Olivier GILG and Sophie MONTUIRE

10:50 – 11:30 Coffee break

11:30 – 11:50
Identification of morphologically close species: the case of voles and lemmings (Rodentia) and paleobiogeographical implications
Sophie MONTUIRE, Louis ARBEZ, Aurélien ROYER, Emmanuel DESCLAUX and N. NAVARRO

11:50 – 12:10
Application of micro-Computed Tomography (µCT) to the analysis of SDQ in *Arvicola*
Elisa LUZI, Iván REY-RODRÍGUEZ, Gabriel S. FERREIRA and Nicholas J. CONARD

12:10 – 12:30
Ancient DNA of narrow-headed voles reveals common features of the Late Pleistocene population dynamics in cold-adapted small mammals
Mateusz BACA, Danijela POPOVIĆ, Alexander K. AGADZHANYAN, Katarzyna BAC, Nicholas J. CONARD, Helen FEWLASS, Thomas FILEK, Michał GOLUBIŃSKI, Ivan HORÁČEK, Monika Vlasta KNUL, Magdalena KRAJCARZ, Maria KROKHALEVA, Loïc LEBRETON, Anna LEMANIK, Lutz MAUL, Doris NAGEL, Leonid REKOVETS, Sara E. RHODES, Aurélien ROYER, Natalia V. SERDYUK, Maria SORESSI, John R. STEWART, Tatiana STRUKOVA, Sahra TALAMO, Jarosław WILCZYŃSKI, Adam NADACHOWSKI

12:30 – 12:50
Using micro-CT scans and 3D morphometrics for taxonomic studies of rodents from Ghar-e Boof in Fars Province (Southern Zagros, Iran)
Iván, REY-RODRÍGUEZ, Beatriz GAMARRA, Gabriel FERREIRA, Mario MATA-GONZÁLEZ, Àngel BLANCO-LAPAZ, Britt M. STARKOVICH, Mohsen ZEIDI and Nicholas J. CONARD

12:50 – 14:30 Lunch break

Session 2 – POSTERS
(14:30 – 15:20)

Moderate by: Dr. Iván Rey-Rodríguez

14:30 – 14:35
Morphometric geometry as a tool in palaeoecological, biostratigraphic and taxonomic studies, on the example of shape variation of the first lower molar in *Alexandromys oeconomus*
Paweł SOCHA and Anna LEMANIK

14:35 – 14:40
Rodent taphonomy from Late Pleistocene sites in Poland
Anna LEMANIK and Paweł SOCHA

14:40 – 14:45
Taxonomic and taphonomic interpretations of a partial skeleton of a Pliocene mole (Talpidae, Mammalia) from Camp dels Ninots fossil site
Adriana LINARES-MARTÍN, Marc FURIÓ, Hugues-Alexandre BLAIN, Gerard CAMPENY and Bruno GÓMEZ DE SOLER

14:45 – 14:50
Applying UDA-ODA discrimination technique to Middle Palaeolithic levels from Abric Romaní site, north-eastern Iberian Peninsula
Ana FAGOAGA, Mónica FERNÁNDEZ-GARCÍA, Juan Manuel LÓPEZ-GARCÍA, M. Gema CHACÓN, Palmira SALADIÉ, Josep VALLVERDÚ, Hugues-Alexandre BLAIN and Francisco J. RUIZ-SÁNCHEZ

14:55 – 15:00
When the opportunist becomes specialist: Comparison of the small mammal diet of eagle owl and barn owl in southwest Spain
Sara GARCÍA-MORATO, Dores MARIN-MONFORT, Yolanda FERNÁNDEZ-JALVO

15:00 – 15:05
Towards a better understanding of the ecological preferences of modern gerbils and its application to paleoclimatic reconstructions
Laura SÁNCHEZ-LÓPEZ, Ana FAGOAGA, Hugues-Alexandre BLAIN, Francisco J. RUIZ-SÁNCHEZ

15:05 – 15:10
Evaluation of different cleaning methods and derived modifications on small mammal's teeth
Noé VALTIERRA, Andrea DÍAZ-CORTÉS, Iván REY-RODRÍGUEZ, Héctor DEL VALLE, Beatriz GAMARRA, Gabriel FERREIRA, Behrouz BAZGIR

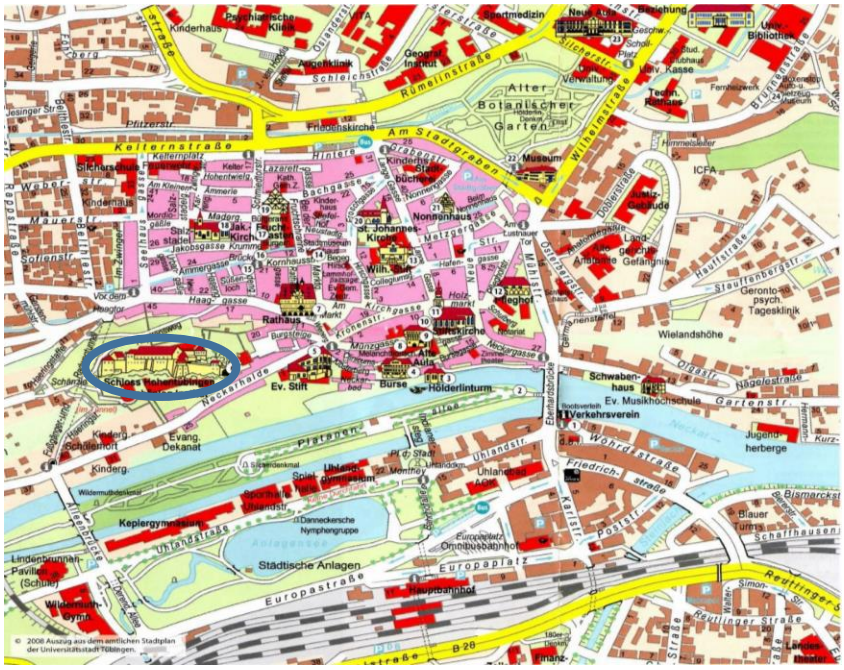
15:10 – 15:15
Herpetological remains from the lower Magdalenian site of El Juyo (Cantabria, Spain)
Hugues-Alexandre BLAIN, Christian SÁNCHEZ-BANDERA, Josep Francesc BISBAL-CHINESTA, Melissa MENSCHEL and James T. POKINES

15:20 – 15:50 Coffee Break

SPECIAL ORAL COMMUNICATION
Special Guest Speaker: Dr. Yolanda Fernández-Jalvo
Title: When small is large: The great value of small vertebrate vs. large mammal taphonomy (a comparison of pre- and post-burial processes)
(15:50 – 16:30)

16:30 – 17:30 General discussion

18:00 All together to the MUT (Museum of the University of Tübingen) at the Castle (Schloss Hohentübingen)



FRIDAY 9th September 2022

Session 3.1 – LANDSCAPE AND MICROVERTEBRATES (09:30 – 12:40)

Moderate by: Dr. Elisa Luzi

09:30 – 09:50
The Small Mammal Assemblage of Cudó Cave (Mont-ral, Tarragona): Late Pleistocene Environmental Reconstruction of Northeastern
Dama Q. ARJANTO, Mónica FERNÁNDEZ-GARCÍA, Juan Manuel LÓPEZ-GARCÍA and Josep Maria VERGÈS

09:50 – 10:10
El Mirador cave (Late Pleistocene to Holocene): a key locality for understanding the extant configuration of Iberian bats
Julia GALÁN, Sandra BAÑULS-CARDONA, Gloria CUENCA-BESCÓS and Josep María VERGÈS

10:10 – 10:30
The Last Glacial Maximum sequence of Grotta della Ferrovia (Fabriano, Ancona, Italy). Direct radiocarbon dating and genetic studies on small mammals to detect and describe the chronology of the past climate oscillations
Claudio BERTO, Letizia CEREGATTI, Helen FEWLASS, Mateusz BACA, Elisa LUZI and Marco PERESANI

10:30 – 10:50
The environmental conditions in northern Iberia during Middle-to-Upper Paleolithic transition based on the small mammals' record
Mónica FERNÁNDEZ-GARCÍA, Marco VIDAL-CORDASCO and Ana B. MARÍN-ARROYO

10:50 – 11:10
Confirming the sub-tropical paleoecology of Yahuai cave in Guangxi, China at 120 kya though the identification of rodent remains
Kathleen KELLEY, Guangmau XIE, Qiang LIN and Miriam BELMAKER

11:10 – 11:40 Coffee break

11:40 – 12:00
Mid-European small mammals during the Early/Middle Pleistocene Transition
Ivan HORÁČEK, Oldřich FEJFAR, Stanislav ČERMÁK, Tereza HADRAVOVÁ, Eva TRÁVNÍČKOVÁ, Markéta ROZKOŠNÁ, Nikoleta DUBJELOVÁ and Jan WAGNER

12:00 – 12:20
Small vertebrates from the level QS-3 from the site of Quibas (Early Pleistocene, Murcia, Spain)
Albert NAVARRO, Carles RESTREPO, Pedro PIÑERO, Jordi AGUSTÍ and Marc FURIÓ

12:20 – 12:40
Revising the small mammal assemblage of the Early Pleistocene site of 'Ubeidiya, Israel: taxonomy, taphonomy and paleoecology
Miriam BELMAKER, Kathleen C. KELLEY, Robyn R. MESSER and Omry BARZILAI

12:40 – 14:30 Lunch break

Session 3.2 – LANDSCAPE AND MICROVERTEBRATES (14:30 – 15:50)

Moderate by: Claudio Berto

14:30 – 14:50
A new Early Pliocene vertebrate site from the Duero Basin (central Iberian Peninsula)
Pedro PIÑERO, David Manuel MARTÍN-PEREA, Paloma SEVILLA, Jordi AGUSTÍ, Hughes-Alexandre BLAIN, Marc FURIÓ and César LAPLANA

14:50 – 15:10
New Gelasian small vertebrate assemblage from northeastern Iberia: chronological and environmental remarks
Juan Manuel LÓPEZ-GARCIA, Pedro PIÑERO, Hugues-Alexandre BLAIN, Jordi AGUSTÍ, Marc FURIÓ, Julia GALÁN, Blanca MONCUNILL-SOLÉ, Francisco Javier RUIZ-SÁNCHEZ, Montserrat SANZ and Joan DAURA

15:10 – 15:30
Exotic taxa do matter: the herpetofaunal assemblages from the Early Pleistocene sites of Barranco León and Fuente Nueva 3 (Granada, Spain)
Christian SÁNCHEZ-BANDERA, Ana FAGOAGA MORENO, Hugues-Alexandre BLAIN and Juan Manuel JIMÉNEZ-ARENAS

15:30 – 15:50
The small-mammal record from the Aceramic Neolithic tell site of Chogha Golan (Iran): paleoenvironmental and archaeological implications
Mario MATA-GONZÁLEZ, Iván REY-RODRÍGUEZ, Britt M. STARKOVICH, Mohsen ZEIDI and Nicholas J. CONARD

15:50 – 16:20 Coffee break

16:20 – 17:30 General discussion and closing Congress speech by Dr. Sara E. Rhodes and Ángel Blanco-Lapaz: Next MVWG host and MVWG prizes

19:00 MVWG Dinner at Schnitzel Akademie (Herrenberger Strasse, 34)

SATURDAY 10th September 2022

UNESCO Swabian Jura Excursion

08:00 Start of the excursion

09:30 Hohle Fels Cave tour (Schelklingen, Ach Valley)

11:00 URMU Museum tour (Blaubeuren)

Urgeschichtliches Museum Blaubeuren | Willkommen (urmu.de)

12:00 Start of the excursion at Lone Valley

12:30 Lunch (Vogelherd archaeopark)

14:00 ca. Vogelherd archaeopark tour and social network

Archäopark Vogelherd – UNESCO World Heritage full of adventures (archaeopark-vogelherd.de)

Oral Communications and Posters

Understanding the morphological variability, the example of north American Collared Lemming (*Dicrostonyx* sp.)

Louis ARBEZ [1,2], Aurélien ROYER[1], Olivier GILG [3,4], Sophie MONTUIRE[1,2]

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Abstract

Fossil identification is mainly based on morphological description of specimens, so that morphology is one of the cornerstone of large-scale studies on past biodiversity. If this statement can seem like common sense, it also rarely considers the intra and inter-specific morphological variability of fossil populations. For a better understanding of species evolution through time and space, it is crucial to quantify and characterize the morphological variability which can be linked to habitat characteristics, climatic conditions or environment (e.g. Caumul and Polly, 2005). Drawing conclusions from such variability is problematic due to a lack of modern referential that could help us interpret the morphological signal in relation to biotic and abiotic parameters. Rodents constitute a substantial part of the Quaternary fossil faunas, and thus are often used as paleoenvironmental proxies. A detailed knowledge of rodent fossil populations appears to be decisive in studying past biodiversity.

This work proposes an in-depth look into the morphological characteristics and variation in both shape and size of the first lower molar of three North American Collared Lemming species (*Dicrostonyx groenlandicus, D. richardsoni, D. hudsonius*) which are key taxa of past and modern Arctic ecosystems (Oksanen et al., 2008). Applying 2D geometric morphometrics on a large dataset (652 specimens) from Northern Canada, the Canadian archipelago and Greenland, our results highlight the existence of a geographical gradient structuring the overall 1st lower molar morphology of Lemming populations. Morphological variability is much more important in central archipelago populations compared to Northern and continental populations. At the intra-specific level, we demonstrate that *D. groenlandicus* is differentiated in two groups on both sides of the Perry Channel, as well as the existence of specific morphological features for Greenland populations, thus emphasizing the role of geographic barriers in morphological signal. These results are congruent with the genetic data.

In addition to providing insights into the population structure of North American *Dicrostonyx* species at a large geographical scale, this presentation aims to investigate the reliability of morphological signal when studying modern and past biodiversity.

References

Caumul, R., Polly, P.D. (2005). Phylogenetic and environmental components of morphological variation: skull, mandible, and molar shape in marmots (*Marmota*, Rodentia). Evolution, 59.

Oksanen, T., Oksanen, L., Dahlgren, J., Olofsson, J. (2008). Arctic lemmings, *Lemmus* spp. and *Dicrostonyx* spp.: integrating ecological and evolutionary perspectives. Evolutionary Ecology Reasearch, 10: 415-434.

Identification of morphologically close species: the case of voles and lemmings (Rodentia) and paleobiogeographical implications

Sophie MONTUIRE[1,2*], Louis ARBEZ[1,2], Aurélien ROYER [2], Emmanuel DESCLAUX[3], and N. NAVARRO [1,2]

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Abstract

Accurate species identification, especially for fossil remains, is a complex task but essential to better understand the evolutionary history and paleobiogeographical expansion of species. During the Quaternary, voles and to a lesser extent lemmings were abundant and they are considered as good climatic markers. Their identification is usually based on the first lower or third upper molars. The common vole *Microtus arvalis* (Pallas, 1778) and the field vole *Microtus agrestis* (Linnaeus, 1761) are commonly found in Middle and Late Pleistocene paleontological and archaeological sites of Western Europe.

These two species are genetically and ecologically divergent, but their first lower molars exhibit a large morphological variation that can potentially lead to some confusion. Moreover, recent molecular data suggest that present-day *M. agrestis* populations are a complex of divergent lineages, some of them being recognized nowadays as valid species. So, in the case of these morphologically close species, decision making of taxonomic attribution is not always obvious and can be subjective. Indeed, depending on populations, some individuals present the clear characteristics of the species (such as, in *M. agrestis*, a strong tooth asymmetry or the presence of a new supplementary triangle at the anterior loop on M_1, and a supplementary loop on the second upper molar M^2) while others can be less typical. The same kind of observation can also be made about lemmings and in particular for the identification, in the fossil material, of *Myopus*, a bryophage specialist typically inhabiting only in boreal forests, which has often been mixed up with the tundra lemming (*Lemmus* spp.), a rodent inhabiting the Arctic open landscape.

Based on the extant populations, this study presents a morphological approach to statistically differentiate these species and is then applied on fossil populations. The method is based on the analysis of tooth outline, landmarks and semi-landmarks describing the most variable parts of the teeth. This method is thus statistically consistent and it is a new tool to discriminate those species. Applied on fossils, some discrepancies with previous classical classification suggest that some existing faunal lists should sometimes be revised for these species. Our study attests the contribution of geometric morphometrics to a better understanding of small mammal communities and the implication in paleoenvironmental reconstructions.

Application of micro-Computed Tomography (µCT) to the analysis of SDQ in *Arvicola*

Elisa LUZI [1], Iván REY-RODRÍGUEZ [2,3,4], Gabriel S. FERREIRA [5,4], Nicholas J. CONARD [5,6].

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Abstract

The SDQ ratio (abbreviation of the German term "Schmelzband-Differenzierungs-Quotient", English: quotient of enamel band differentiation) quantifies the relation: enamel thickness of posterior vs anterior walls in the molars of Arvicolinae. This parameter was introduced on first lower molars (m1s) by Heinrich (1978). He used it as a biochronological tool for dating Middle and Late Pleistocene *Arvicola* samples, since this ratio undergoes successive changes in geological time. The SDQ of an m1 is the average of the above mentioned ratio for all 7 triangles of this tooth (T1 to T5, and the two sides of posterior lobe), thus

$$SDQ_{m1} = \Sigma\, SDQ_{T} / 7.$$

In a population it is the mean of all (n) m1s considered

$$SDQ_{pop} = \Sigma\, SDQ_{m1} / n$$

Because of taphonomic processes, such as digestion or abrasion, it is not always possible to measure the enamel thickness accurately. This can lead to wrong results or a low sample size reducing the informative value of the method. Micro-Computed Tomography (µCT) might be used to "cut" below the damaged surface, and thus taking appropriate measurements, which increases sample size in SDQ studies. To test the potential of this technique, we analysed material of *Arvicola amphibius* from geological horizon 15 of the Hohle Fels Cave (Luzi et al., 2022). First, we analysed 12 complete specimens as a control group, to check whether the enamel thickness changed at different levels of the tooth crown. Then we scanned specimens with breakages, digestion marks and/or irregular abrasion of the occlusal surface. In our study, we used a Nikon XTH 320 device with an acceleration voltage of 135 kV, current of 155 µA and voxel size of 0.012 mm, and took measurement with 3D Slicer software. For the m1s in the control group, the SDQ values obtained at the occlusal surface was compared to the SDQs obtained at different cuts from the surface. The values were considered equivalent with p-value ≥ 0.95, calculated with one-way ANOVA. We observed constant SDQ values in the upper 30 ortho-slides corresponding to 0.36 mm down from the level of the occlusal surface. Between 30 and 40 ortho-slides (to 0.48 mm below the occlusal surface), the SDQ values start to increase. However, the p-values still remained > 0.70.

With our test run, we can confirm that it is possible to bypass at least the more superficial damages using µCT scans, and we were thus able to increase the sample size from the original 12 specimens to 26. We can generally conclude that µCT is a useful tool in the study of evolutionary patterns of *Arvicola* dental morphology.

References

Heinrich, W.D. (1978) Zur biometrischen Erfassung eines Evolutionstrends bei *Arvicola* (Rodentia, Mammalia) aus dem Pleistozän Thüringens. Säugetierkundliche Informationen, 2:3–21.

Luzi, E., Blanco-Lapaz, À., Rhodes, S.E., Conard, N.J. (2022) Paleoclimatic and paleoenvironmental reconstructions based on the small vertebrates from the Middle Paleolithic of Hohle Fels Cave, SW Germany. Archaeological and Anthropological Sciences, 14:107. doi:10.1007/s12520-022-01568-5

Ancient DNA of narrow-headed voles reveals common features of the Late Pleistocene population dynamics in cold-adapted small mammals

Mateusz BACA[1], Danijela POPOVIĆ[1], Alexander K. AGADZHANYAN[2], Katarzyna BACA[1], Nicholas J. CONARD[3], Helen FEWLASS[4], Thomas FILEK[5], Michał GOLUBIŃSKI[1], Ivan HORÁČEK[6], Monika Vlasta KNUL[7], Magdalena KRAJCARZ[8], Maria KROKHALEVA[9], Loïc LEBRETON[10], Anna LEMANIK[11], Lutz MAUL[12], Doris NAGEL[5], Leonid REKOVETS[13], Sara E. RHODES[14], Aurélien ROYER[15], Natalia V. SERDYUK[2], Maria SORESSI[16], John R. STEWART[17], Tatiana STRUKOVA[9], Sahra TALAMO[18], Jarosław WILCZYŃSKI[11], Adam NADACHOWSKI[11]

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Abstract

Narrow-headed voles, together with collared lemmings and common voles, were the most abundant small mammal species across the Eurasian Late Pleistocene steppe-tundra environments (Kowalski, 2001). Previous ancient DNA studies of the latter two revealed a dynamic past population history shaped by climatic fluctuations (Baca et al., 2020; Palkopoulou et al., 2016). To investigate the extent to which species with similar adaptations share common evolutionary histories, we generated a dataset comprising mitochondrial genomes of 139 ancient and 6 modern narrow-headed voles from multiple sites across Europe and western Asia, covering the last ca. 100 thousand years. We inferred Bayesian time-aware phylogenies with the ages of directly radiocarbon-dated samples used for molecular clock calibration. We found that, across the three species, divergence of the main mtDNA lineages occurred during MIS (Marine Isotope Stage) 7 and MIS 5, suggesting that the species adapted to open and cold habitats showed common responses to interglacial environmental pressures. In European narrow-headed voles, we identified multiple time-structured mtDNA lineages, implying population turnovers. Timing of some of these turnovers was synchronous across all three species, suggesting the reduction of open habitats during interstadials as the main driver of the Late Pleistocene dynamics of steppe- and cold-adapted species.

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Using micro-CT scans and 3D morphometrics for taxonomic studies of rodents from Ghar-e Boof in Fars Province (Southern Zagros, Iran)

Iván, REY-RODRÍGUEZ[1,2,3], Beatriz GAMARRA[3,1], Gabriel FERREIRA[2,4], Mario MATA-GONZÁLEZ[5], Àngel BLANCO-LAPAZ[4], Britt M. STARKOVICH[4,5], Mohsen ZEIDI [4,6], Nicholas J. CONARD [4,5,6]

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Abstract

Among different rodent species found in the Zagros, *Meriones* is one of the most diverse among the tribe Gerbillini in the Palaearctic region, with a geographic range that covers North African and Asian continents. *Meriones* spp. are generally used for paleoclimate reconstructions, and their habitat generally favours semi-desert regions and mountain steppe, as well as alluvial plains, cultivated valleys and arid saline flats.

Until now, the literature on skull characteristics to properly identify fossil taxa in the region is lacking, partially because it is rare to find complete skulls from the Pleistocene. Consequently, the observation of modern reference collections and skull morphology of molecularly defined taxa will allow scientists to improve their identifications in fossil assemblages (Stoetzel et al., 2017). There are several studies conducted on extant *Meriones* skulls using traditional morphometrics or two dimensional Geometric Morphometric (GM) approaches in North Africa and Asian countries (Stoetzel et al., 2017), but scholars have never considered all *Meriones* species together.

The main objective of this study is to evaluate the intra- and interspecific variation in the skulls of *Meriones* species and to identify a *Meriones* skull found in the Upper Palaeolithic level of the Ghar-e Boof site (in Iran), dated by OSL between 37-39 ka (Conard et al., 2019; Heydari et al., 2021). For this study we used the *Meriones* modern reference specimens housed at the Muséum National d'Histoire Naturelle collection (Paris, France) together with comparative morphometric and biometric skull and dental data from the literature. In this study we have included the following species: *M. crassus*, *M. libycus*, *M. tristrami*, *M. hurrianae*, *M. meriadianus*, *M. persicus*, *M. vinogradovi*, *M. zarudnyi*, *M. sacramenti*, *M. unguiculatus*, *M. tamariscus*, *M. shawii* and *M. rex*. We also included *Tatera* and *Rhombomys* genera in a fossil context, where we usually have isolated teeth, and can easily be confused with *Meriones* due to similar molar morphology.

The methodology employed is based on three-dimensional (3D) GM methods and high resolution microcomputed tomography (µCT). A total of 26 landmarks and 56 semi-landmarks were digitized using Viewbox 4 dHAL software. Shape coordinates were imported and a generalized procrustes analysis was performed using *geomorph* and *Morpho* packages in R. A principal component analysis (PCA) was then performed on the new normalized landmark and semi-landmark coordinates of the reference collection. The archaeological specimen was added *a posteriori* as a supplementary individual in the PCA shape space. The allometric effect was investigated through univariate and multivariate linear regression of the PCA scores on the log of the centroid size.

By combining shape and size variables, it was possible to preliminarily identify the Ghar-e Boof *Meriones* skull as *Meriones rex*. This designation is based on the cranial structure, the suprameatal triangle, the auditory meatus, the mastoid and the bulla morphology, as well as the size, since they were retrieved as important components of variation to differentiate between the different reference species. Our study, based on 3D GM, enabled us to obtain more efficient fossil specie attribution than classical craniometric analysis in *Meriones* species.

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Morphometric geometry as a tool in palaeoecological, biostratigraphic and taxonomic studies, on the example of shape variation of the first lower molar in *Alexandromys oeconomus* (Pallas, 1776)

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Abstract

The use of geometric morphometric studies in palaeontological research on fossil rodent remains allows a better understanding of species relationships, trends and migration directions. These studies also provide important information in taxonomy and functional morphology.
Analysis of m1 morphological structure in the subfamily Arvicolinae is commonly used to determine the taxonomic status of fossil remains and provides palaeoecological and biostratigraphic data. However, the use of the observed features of morphological variation in m1, in these studies, is associated with a number of limitations. These are due to the geographical variability observed in modern and fossil populations, species with wide ranges. In fossil populations, temporal variability is an additional complication. Furthermore, a similarity in the morphological structure of the occlusal surface of m1 Arvicolinae is observed in both modern and fossil populations. This similarity can be both interspecific and intergeneric.

One species characterised today by a wide geographical distribution in the Northern Hemisphere is *Alexandromys oeconomus*. This species is also abundantly represented in glacial and interglacial sediments from the Middle to Late Pleistocene. The morphometric results indicate that the occlusion surface m1 of this species is characterized by geographical and temporal variability. At the same time, the surface m1 shows similarities not only with other representatives of the genus *Alexandromys*, but also with other genera, e.g. *Chionomys* (Chaline 1972; Nadachowski 1982; Voyta et al. 2013).
The results of a geometric analysis conducted on m1 *A. oeconomus*, based on 15 landmarks and 30 semilandmarks from the Middle and Late Pleistocene from Poland showed differences between the separated morphotypes in this species. Canonical analysis showed statistically significant differences between the separated morphotypes. The "*malei"* morphotype (highest Mahalanobis distance values) and the *"nivalis"* morphotype differed most clearly from the other morphotypes. In contrast, the smallest differences were found between the *"oeconomus"* and *"gud"* morphotypes.
At the same time, a comparison of the mean values of the linear measurements of the m1 occlusion area in *A. oeconomus* showed statistically significant differences between the separated morphotypes. These differences were mainly found between the *"malei"* morphotype and the other morphotypes. Furthermore, the results obtained indicate the existence of differences in the shape of the occlusion surface and the variation in its linear dimensions within the separated morphotypes, and these changes show a relationship with climatic and habitat conditions.

The study carried out using geometric morphometric analysis will allow a better estimate of the morphological variability of m1 in modern and fossil populations of *A. oeconomus*. It will also allow an attempt to resolve the taxonomic status of some specimens characterized by morphological structure atypical for this species. At the same time, the use of geometric

morphometric analysis will allow us to correlate changes in the structure of the m1 occlusion area as a function of climatic and habitat conditions within the separated m1 morphological types in *A. oeconomus*. This research will provide a better understanding of the impact of climatic changes on the morphological structure of m1.

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Rodent taphonomy from Late Pleistocene sites in Poland

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Abstract

The recognition of the genesis of accumulations of rodent remains at archaeological and palaeontological sites is very important and it could give important information for the fossil assemblage interpretation. Rodent remains are a fundamental source of information in numerous studies including palaeoecology and biostratigraphy. The formation of accumulations of rodent remains is most often associated with predator activity. Predator activity is indicated by traces of digestion observed on the skeletons of their prey. Observation of prey remains of modern predators provides a basis for the recognition of the predator category in the case of fossil remains (Andrews 1990; Fernández-Jalvo et al. 2016). In fossil assemblages, predator category identification based only on the degree and frequency of digestion can be problematic. In these assemblages, there may be mixing of food remains from different predators from different category. In typifying potential predator(s), it is helpful to observe signs of predation using the taxonomic criterion of prey.

The study analysed rodent remains from cave and open sites located in southern Poland (Borsuka cave, Mamutowa cave, Kraków Spadzista, Jaksice II). At these sites, the accumulation of remains occurred during the Late Pleistocene (MIS 3 and MIS 2). In all the sites studied, digestion marks were found on the remains of small mammals indicating the contribution of predators to the accumulation of their remains. The results of the comparative taphonomic analyses showed differences in the proportions of digested to undigested remains and the degrees of intensity of digestion between the sites studied and between separate layers within the same site. These differences were also found within individual prey species. Comparative analyses of digestion traces within individual prey species only yield meaningful results within sites characterised by a high abundance of remains. We also found differences in the proportions of digested to undigested remains and degrees of digestion intensity between different prey species within a layer from the same site. These differences were most marked between prey species that differed in their ecological requirements and diurnal activity, e.g. between *Clethrionomys glareolus* and *Lemmus lemmus*. The results indicate that predators belonging to more than one species were involved in the accumulation of small mammal remains at the study sites. Predator species differed in their ecological preferences and hunting strategies.

The results obtained from the taphonomy study of rodents will enable a more accurate identification of the factors influencing the accumulation of their remains. Incomplete recognition of the mode of accumulation of these remains makes it difficult to decide whether the assemblage under study reflects, as far as possible, the taxonomic biodiversity of rodents occurring in the past in the vicinity of the site under study. It also makes it difficult to decide whether the observed changes in the taxonomic composition of rodents are the result of climatic and environmental changes or the food selectivity of predators.

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Taxonomic and taphonomic interpretations of a partial skeleton of a Pliocene mole (Talpidae, Mammalia) from Camp dels Ninots fossil site

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Abstract

The Pliocene fossil site of Camp dels Ninots (ca. 3.3-3.1 Ma) represents one of the most remarkable paleontological sites whose exceptional preservation confers it the treatment of Konservat-Lagerstätten. Camp dels Ninots is placed in one of the craters of the Catalan Volcanic Complex at the NE of the Iberian Peninsula (Martí *et al*., 1992). This maar-type fossil site has delivered many articulated skeletons of vertebrates such as bovids (*Alephis tigneresi*), tapirs (*Tapirus arvernensis*), rhinoceros (*Stephanorhinus* cf. *jeanvireti*), turtles (*Mauremys leprosa* and *Chelydropsis* cf. *pontica*), amphibians (cf. *Pleurodeles* sp., *Lissotriton* aff. *Helveticus* and *Pelophylax* sp.) and freshwater fishes (*Leuciscus* sp. and *Luciobarbus* sp.) (Gómez de Soler *et al*., 2012; Přikryl *et al*., 2016). To a lesser extent, also invertebrates, micro- and macroflora (*Laurophyllum*) have been found. However, the fossils of small mammals, usually abundant in other sites of similar age, are surprisingly scarce in Camp dels Ninots. Hitherto, small mammals were only represented by rodents (*Apodemus atavus*) but has recently delivered one of the most complete skeletons of a talpid ever found. The fossil remains found include almost the whole mandible, part of the upper dentition and many postcranial remains in anatomical connection. Because of the ease deterioration of micro remains digital reconstructions from a micro-CT scanner have been carried out to obtain 3D models of almost all the skeletal elements preserved. The compact and broad humerus, as well as the strong development of the ulna and radius are indicative of a highly fossorial form with a complex forelimb structure.

These traits compared with those shown in fossil talpids placed this mole in a complicated situation. This specimen cannot be accommodated, neither at species nor genus level, with the fossil specimens hitherto found and the extant ones; therefore, this fossil remains could be related to a new genus and species of scalopine mole. In the absence of any taphonomical indications of scavenging, the mole apparently sank into the water and its corpse decomposed at the bottom in relatively calm and anoxic conditions. Besides that, is known that the moles have the ability of swimming but is not common, so the morphological features of this specific mole suggest extra capabilities for that or even for digging. In addition to providing relevant taphonomic information as to how it could have reached the lake. The morphology of the maar-type lakes, such as the vertical walls, could provide important information about the capabilities of this specimen.

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Applying UDA-ODA discrimination technique to Middle Palaeolithic levels from Abric Romaní site, north-eastern Iberian Peninsula

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Abstract

One of the major challenges in scientific research concerns understanding past climate and the mechanisms of climate change. Small vertebrates are especially sensitive to shifts in climate and habitat, and their variations over time in terms of taxa and abundance can be successfully used for past environmental reconstructions. Small mammals, especially rodents, are widely used to reconstruct terrestrial Quaternary climates and environments because their high reproduction rates, specific ecological requirements, and infrequent migratory behavior make them precise indicators of environmental change. The vast array of palaeoclimatic reconstruction approaches (such as the Bioclimatic Model (BM); the Mutual Ecogeographic Range (MER); or oxygen stable isotope composition ($\delta^{18}O$) analyses) reflects great effort invested in estimating past temperatures and precipitation. Recently, the Uncertain Distribution Area-Occupied Distribution Area (UDA-ODA) discrimination technique, a procedure of overlapping current and more precise species distribution (ODA) to extrapolate mean climatic values to fossil assemblages, has been postulated as a more reliable ecological-based methodology. Results of its application to El Salt and Abric del Pastor Middle Palaeolithic sites (south-eastern Spain) showed that resulting climatic values are more accurate than considering the normally utilized 10×10 km grid distributions recorded in current Atlases and employed by the MER method (Fagoaga et al., 2019).

To provide biogeographical information to be used following the UDA-ODA discrimination technique, four species' distributions (*Sorex minutus*, *Chionomys nivalis*, *Talpa europaea* and *Crocidura russula*) have been processed to complete the biogeographical data of species documented in levels O, N, E and D from the Abric Romaní site. Results reveal a statistical difference between values belonging to occupational areas (ODA), which constitute more realistic distribution areas linked to each species' requirements, and uncertain distribution areas (UDA). The species distributed in areas with high topographic heterogeneity are more susceptible to produce bias in the climatic reconstructions. After this first step, this technique was applied to small-mammal assemblages from the mentioned levels of Abric Romaní, to test whether the use of ODA's of the species from their fossil assemblages improves the precision of the climatic

reconstruction compared to Atlases distribution of the species used in MER proceedings, also carried out here. Statistical differences between ODA and UDA are obtained only in level D, whose assemblage has the widest geographic extension within the Abric Romaní levels. Together with previous results at Abric del Pastor and El Salt sites, our results suggest an improvement in the discrimination analysis over the previous MER reconstructions using the classical method when wider assemblage's distributions are obtained. When compared to the other methods, the

results from ODA using small mammals point to colder temperatures. In particular, the reconstruction for level O (the richest in number of species) shows the highest range of difference, with MER and UDA-ODA giving the coldest temperature. This may reinforce the pollen interpretation of the level O as coetaneous of a cold period, with the dominance of open and usually cold-considered taxa as *Artemisia*, *Poaceae*, and *Pinus* (Burjachs et al., 2012; Fernández-García et al., 2018).

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When the opportunist becomes specialist: Comparison of the small mammal diet of eagle owl and barn owl in southwest Spain

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Abstract

Small vertebrate assemblages are usually the result of predator accumulations. Predatory activity and predator preferences may have an influence in the general view of the total animal community from which they hunt their prey. Specialist predators only eat certain types of prey, while opportunistic predators take all prey species available within a given size range.

The European eagle owl (*Bubo bubo*) is usually considered a complete opportunist predator due to the varied nature of its diet. However, in the Iberian Peninsula, this large raptor shows a specialist behaviour, not observed in other countries from Europe. Its diet mainly consists of rabbits (*Oryctolagus cuniculus*), while brown rats (*Rattus norvegicus*), hedgehogs (*Erinaceus europaeus*) and hares (*Lepus* spp.) are alternatively consumed in areas of low rabbit abundance (Penteriani and Delgado, 2019). Considering these dietary preferences, small mammal assemblages accumulated by eagle owls in the Iberian Peninsula could be extremely biased, causing distorting effects in palaeoecological inferences.

In this work, we analysed how the diet of eagle owls considerably varies in comparison with other nocturnal predators and how it may affect palaeoecological inferences from Iberian sites. A bibliographic review of the taxonomic diversity of small mammals from 28 eagle owl nests was compared with 23 barn owl nests (*Tyto alba*), an overall opportunist predator, in the southwest Iberia. Results indicated important differences between both predator assemblages. In general terms, the body mass of the prey spectra hunted by eagle owls is usually between 200 g and 2 kg, when lagomorphs are considered, and between 200-800 g considering only small mammals (< 1kg). Barn owls usually accumulated prey of less than 200 g, including incidentally some young rabbits. These results indicate that an important bias related to prey size intake is present and this fact may affect to palaeoecological inferences. Differences were also observed in the representation of the different taxonomic groups, with murids being the most frequent prey consumed by barn owls and arvicolines and glirids the best represented taxa in eagle owl assemblages when lagomorphs are not considered. These differences in prey assemblages from different predators were pointed out by Andrews (1990), which demonstrated the presence of differences between the prey spectra for three different predators hunting over the same area within one-time period. The application of the Habitat Weighting Method indicates different environmental conditions depending on the predator evaluated. Barn owl assemblages are dominated by open dry/humid environments and open woodland and open humid areas are best represented in eagle owl accumulations when lagomorphs are included in these analyses. On the contrary, in eagle owl prey assemblages in which only small mammals are considered wetland and woodland areas constituted more than the 50% of the habitats represented.

These preliminary results highlight the necessity of applying taphonomic analyses prior to any palaeoecological inference. Likewise, knowing the feeding ecology of the predators in the different

areas inhabited also plays a key role once a predator has been identified as the main accumulation agent of a small mammal assemblage.

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Towards a better understanding of the ecological preferences of modern gerbils and its application to paleoclimatic reconstructions

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Abstract

High reproduction rates, specific ecological requirements and infrequent migratory behaviour make rodents precise indicators of environmental change; and therefore they have been widely used as climate proxies. Past climate characteristics and parameters can infer through rodent fossil assemblage applying methods such as the Mutual Ecogeographic Range method (MER) (Blain *et al*., 2016) or the Bioclimatic Analysis (Hernández Fernández, 2001) among others. Some of these methods require a previous good understanding of species' current distribution and ecological preferences.

In this work, we study the subfamily Gerbillinae which includes 14 extant genera and 103 species, which are currently distributed in (semi-)deserted areas in Africa and Southwest Asia. We focus on gerbils because they are key species to better understand the environmental context of migratory events; namely the faunal exchange between Africa and the Iberian Peninsula during the Messinian Salinity Crisis or the dispersal of early hominids towards Eurasia. They are recorded from Late Miocene to Early Pliocene in the Iberian Peninsula (e.g. Almenara-M, Salobreña, Alcoy, Botardo) and in some of the oldest sites documenting genus *Homo* out of Africa in Early Pleistocene such as Dmanisi (Georgia) and Ubeidiya (Israel). We characterize the environmental preferences of 90 modern gerbil species by analyzing their current geographic distribution in terms of the bioclimatic variables from the WorldClim database (Hijmans *et al*., 2005) and the biomes. We aim to observe if there are differences in ecological preferences between genera and within them; and also ascertain if the entire subfamily lives within restricted climatic ranges typical of arid ecosystems, as traditionally been said in literature. For this purpose, we use Geographic Information System (GIS) tools and apply a cluster analysis.

As a result, the 90 gerbil species analyzed are differentiated into 4 groups according to their similarity concerning their climatic preferences. The 82% of species, regarding groups 1 – 2 – 4, have ecological requirements linked to desert climates (annual precipitation < 250 mm) and sub-desert climates (annual precipitation between 250 -700 mm). However, it has been observed that species from group 3 (18%), have preferences for sub-humid and humid climates according to the quantitative values of the precipitation biovariables. It has also been inferred that 76% of gerbil species (groups 1 – 2 – 3) are linked to warm climates (mean annual temperature > 18ºC), nevertheless group 4 is linked to temperate and even cold climates. The climatic characteristics of the gerbils are supported by their distribution over biomes; being the most inhabited: desert and xeric scrublands (55%) and tropical and subtropical grasslands, savannahs, and scrublands (24%). The subfamily Gerbillinae is not fully characterized by the same ecological requirements. There are differences between and within genera.

In conclusion, overall gerbils are good indicators of arid environments, as has been said in literature. However, this work depicts the unique quantitative environmental characterization of modern species of the subfamily Gerbilinae. As the entire subfamily does not share the same climatic preferences, knowing the ecological requirements of modern relatives' species appears as a requisite in the assessment of the climatic conditions of a fossil site.

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Evaluation of different cleaning methods and derived modifications on small mammal's teeth

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Abstract

In many cases, it is essential to apply cleaning treatments to remove sedimentary crusts or matrices to be able to carry out further studies. These treatments must be adapted to the characteristics of the material and be as innocuous, reversible and neutral as possible.

In general, cleaning processes applied on archaeological material and, specifically, small mammal remains, involve several specific issues. The small size of the rodent teeth makes it very difficult to handle them during the process and for these reason, chemical methods are usually chosen. However, the main difficulty of this option is the lack of control which might be harmful for bony materials. This may affect the subsequent taxonomical and taphonomical studies applied to these materials (Fernández-Jalvo *et al*. 2016; Rey-Rodríguez *et al*. 2019).

The aim of this study is to evaluate different products in combination with mechanical tools for the cleaning of gerbil (*Meriones*) teeth (n=13) with crusts on their surface, from Kaldar Cave site in Western Iran (Bazgir *et al.* 2017). Not only to evaluate their efficacy, but to characterize possible modifications on the teeth surface that may interfere with taphonomic studies after cleaning. For this purpose, we used high resolution computed tomography (Micro-CT) to document the teeth, before and after cleaning, identifying these possible changes.

Based on the chemical composition of the sedimentary matrix and the tooth by infrared spectroscopy (ATR-FTIR) analysis, we selected four different products to be evaluated: acetic acid, sodium hexametaphosphate, Tetrasodium ethylenediaminetetraacetic acid (EDTA) and the anion exchange resin IONEX OH. For each product, a total sample of 3 teeth was applied in combination with different methods:

- The product only, without any mechanical interaction.
- Combined with mechanical tools such as punches.
- Combined with an ultrasonic bath using deionised water in 1 min baths.

In the case of the anion exchange resin IONEX OH, a fourth tooth was added on which the product was applied in combination with gentle brushing, following the supplier's recommendations.

The application of the chemical products in combination with mechanical cleaning was effective in all cases. This was not the case applying only the products, which varied in their effectiveness removing the concretion, but was generally ineffective. The results combining ultrasounds were varied, ranging from the destruction of the tooth using acetic acid, to non-affectation applying ion exchange resins, as well as their application with friction. In general, acetic acid was the most

effective product in removing concretions, along with EDTA, while the effectiveness of hexametaphosphate was much lower, and ion exchange resins were ineffective.

Despite the effectiveness of these methods, there is an interaction with the tooth surface. Mechanical cleaning effects are link to scratches, volumetric losses, and other surface modifications. In turn, some of the products cause dentine displacement, opacity, and modifications like those produced by digestion processes. These modifications must be considered when applying these products and methods, otherwise they may influence the applied studies.

In conclusion, some of the products and application methods tested have been effective in removing crusts, but we must be careful with the influence on the material. It must be characterised what degree of modification is acceptable for not interfering subsequent studies by chemical cleaning treatments.

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Herpetological remains from the lower Magdalenian site of El Juyo (Cantabria, Spain)

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Abstract

El Juyo is a Cantabrian Lower Magdalenian cave site located approximately 8 km west of the city of Santander and 5 km south of the present-day coastline of the Cantabrian Sea (Barandiarán et al., 1987). Its deposits were protected by the collapse of the main entrance around 14,000 B.P. and sealed by flowstone. The excavations in the main vestibule covered an area over 40 m^3, and the stratified deposits are up to 3.5 m thick, with an estimated duration of Magdalenian occupation of around 1,000 years. Levels 2 (Medieval) and 3 (Bronze Age) yielded only minor deposits. Levels 4 and 7 yielded radiocarbon dates on charcoal of 13,920 ± 240 B.P. and 14,440 ± 180 B.P., respectively. Levels 6-9 are the lowermost levels which have been exposed over a wide area and contain much occupation debris, including faunal remains. Small exposures of Levels 10 and 11 have been made to date and contain dense concentrations of remains of large animals.

Different proxies have been studied at El Juyo in order to reconstruct the paleoenvironmental and paleoclimatic conditions during the lower Magdalenian occupation of the site, such as sedimentology, pollen, macrobotanical remains, birds, and small and large mammals (see Pokines, 1998, 2000). These previous studies suggested an open, humid meadow environment with some tree cover and with some northern/alpine species extending their ranges to the coastal lowlands under generally cold and dry climatic conditions. Here, we present the study of the herpetofaunal assemblages from the lower Magdalenian sequence from El Juyo and explore their significance in terms of quantitative paleoclimatic and paleoenvironmental reconstructions using different quantitative methods. The herpetofaunal fossil assemblage documented at El Juyo has a much lower diversity than present day, with only 3 taxa: a toad (*Bufo bufo* sensu lato), a frog (*Rana temporaria*) and a viper (*Vipera aspis* or *Vipera seoanei*). In order to propose quantitative data about environment and climate, we used three different methods: Mutual Ecogeographic Range, Quantified Ecology, and Habitat Weighting.

All methods applied to this scarce and poorly diverse assemblages characterized the climate as colder (between -8.5 and -3.7ºC) and dryer (between -415 and -344 mm) than today, with somewhat colder winters (between -15.2 and -5.6ºC in comparison with present values) and similar or even potentially slightly warmer summer (between -2.5 and -1.6ºC in comparison with present values) temperature, whereas landscape reconstructions suggest humid open area together with a potentially good representation of woodland areas in the vicinity of the site. This indicates that the climate during the Dryas 1 was much colder and dryer than today, even if the proximity of the sea may have mitigated in some way the harshness of the climate in this area. Rainfall seasonality pattern changed, between the coldest periods of the Dryas 1 and today, from more abundant precipitation during summer to late fall and winter maximum. Such a very low herpetofaunal diversity during the lower Magdalenian is discussed in the context of other North-Iberian herpetofaunal assemblages with a similar age.

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SPECIAL ORAL COMMUNICATION
Special Guest Speaker: Dr. Yolanda Fernández-Jalvo

When small is large: The great value of small vertebrate vs. large mammal taphonomy (a comparison of pre- and post-burial processes)

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Abstract

Despite Taphonomy has already 82 years, it was just in the 1970s that large mammal taphonomy started to be more extensively analysed. Small vertebrates were neglected for decades (despite the effort of some taxonomists such as C. Denys) until Peter Andrews published his book *Owls, Caves and Fossils* in 1990, a book focused on small mammal Palaeoecology that drove the author to establish the basis of small mammal Taphonomy. Most microvertebrates are result of predation and as such their presence in a fossil site is influenced by hunting preferences and the nature of the predator. Small vertebrates, due to their small size and their rapid metabolism, have a small habitat valuable for palaeoecological interpretations. The former (the prey's habitat) may be known through multiproxy studies, and the latter have hunting preferences where their casual or favourite prey inhabits. The predator's is only deciphered through information recorded on small vertebrate fossils, something that cannot be obtained without the participation of taphonomy. We are going through the information that large and small vertebrates may provide to observe parallelisms between them and, in addition, the supplementary information that small vertebrates yield on past environments and ecosystem. All these conditions and the fact that small vertebrates may also be prey of humans make them a wide reservoir of information.

The Small Mammal Assemblage of Cudó Cave (Mont-ral, Tarragona): Late Pleistocene Environmental Reconstruction of Northeastern Iberia

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Abstract

The Late Pleistocene is a period with highly fluctuating climatic conditions, with the Last Glacial Maximum (LGM) dated 26,5 – 19 ka cal BP (Clark et al., 2009), known to be one of the coldest periods. This event is commonly identified by the maximum extent of polar and mountain ice caps and the drop of sea surface temperatures. It is detected in various palaeoecological proxies, mainly from marine records. Nevertheless, climatic changes are not always affecting the environment in the same way in each region, particularly in the terrestrial domain (e.g., Fletcher and Sánchez Goñi, 2008). In this regard, this work explores how the environment of northeastern Iberia changed in relation to global climatic changes experienced during the Late Glacial.

Small mammal assemblages from Cudó cave (Tarragona, Spain) were analyzed considering the well-known reliability of this mammal's group for paleoenvironmental reconstructions. 14 different small mammal taxa have been identified, i.e., *Crocidura russula*, *Sorex* gr. *araneus-coronatus*, *Rhinolophus* cf. *ferrumequinum*, *Myotis* gr. *myotis-blythii*, *Pipistrellus* cf. *pipistrellus*, *Microtus arvalis*, *Microtus agrestis*, *Microtus* gr. *arvalis*-agrestis, *Microtus* (*Terricola*) *duodecimcostatus*, *Microtus* (*Iberomys*) *cabrerae*, *Chionomys nivalis*, *Apodemus sylvaticus*, *Eliomys quercinus*, and *Sciurus vulgaris*. Based on the taxonomic identification and the taphonomic analysis, several methodologies covering both qualitative and quantitative approaches, including Simpson's diversity index, chorotype analysis, habitat weighting method, bioclimatic model, and Mutual ecogeographic range were used to obtain the paleoenvironmental information corresponding to level 107 and level 105 of Cudó cave (31.2 – 24.4 ka cal BP and 15.5 – 10.2 ka cal BP, respectively). The obtained results, point out a category 3 predator group, specifically *Strix aluco*, as the main accumulator of the small mammals. It can be deduced particularly from the moderately high percentage of digested molars and isolated incisors with moderate to high level of digestion marks. This pattern is distinguishable from which produced by other species of category 3 predators found in Iberian Peninsula, i.e., *Bubo bubo* and *Athene noctua*. Furthermore, the paleoenvironmental reconstruction shows that both levels experienced colder (-7.2°C/-4.4°C) and wetter (+848mm/+586mm) climatic conditions than nowadays. The habitat reconstruction shows in level 107 the environment was dominated by mid-European species and rocky landscape, while in level 105 it was dominated by Mediterranean species and woodland habitat. These conditions are consistent with the trend in northeastern Iberia following several climatic events before and after the LGM coinciding with the period of Cudó cave assemblages (e.g., Cacho et al., 2001).

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Revising the small mammal assemblage of the Early Pleistocene site of ‘Ubeidiya, Israel: taxonomy, taphonomy and paleoecology

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Abstract

Understanding the tempo and mode of early *Homo* dispersal from Africa to Eurasia during the Early Pleistocene is key to our ability to infer human-environment interactions over time and the contribution of the novel environment to our evolution. A significant site that attests to this dispersal is the site of 'Ubeidiya, Israel. The site of 'Ubeidiya lies 3 km south of the Sea of Galilee on today's flanks of the western escarpment of the Jordan Valley. It was first discovered in 1959, and a series of excavations were conducted from 1960 to 1974. 1988-1992, 1997-1999, and most recently in 2021. The site exhibits several extensive Acheulean lithic collections and rich vertebrate fossil assemblages. Over all seasons, ca. 15 cubic meters of sediments were wet sieved through a 1 mm mesh to retrieve the small vertebrate remains.
The small mammals from 'Ubeidiya were extensively published by Tchernov (1986a, b). His results, on a sample of the total specimens recovered, suggested that the small mammal community should be attributed to the Early Biharian small mammal Age and related to 1.1 - 1.4 mya, slightly younger than estimates based on the large mammal fauna, which points to an age of 1.2 – 1.6 mya. Nonetheless, questions on the absolute dating of the site, paleoecology, and community structure throughout the sequence are still outstanding.
Since the publication of the 1986 seminal research, most of the subsequent research on 'Ubeidiya focus on the 'Ubeidiya fauna concentrated on the large mammals. However, there have been many changes in the small mammal taxonomy, additional Early Pleistocene material, and new analytical methods which narrow the biochronological estimate and improve our knowledge and understanding of the biogeographic range of small mammal species. Here we present an updated list of the small mammals of 'Ubeidiya with a focus on updated taxonomy, taphonomy, biochronology, and biogeography, as well as the paleoecological reconstructions based on the analog method and ecometrics.

The common species are *Lagurodon arankae*, *Parameriones obeidiensis,* and *Apodemus sylvaticus, Cricetus, cricetus,* and *Allocricetus bursae* with a high percentage of endemic species. However, revision of the material suggests that the endemic status of some species could not be sustained, e.g., *Parameriones obeidiensis* and the identification of others is debated, e.g., *Parapodemus jordanicus*. Using the analog method, the inferred paleoecology of the entire sequence is typical of Mediterranean park forests. Mesowear analysis of the voles suggests that within the Mediterranean sub-regions of the Southern Levant, 'Ubeidiya had lower temperatures and increased precipitations compared to the environment today with a notable increase in woodland cover. There is a notable change in small mammal community structure through time which is reflected in the paleoecological reconstruction indicating a more humid period in earlier strata compared to an expansion of grassland in younger strata. However, these changes were not reflected in the biochronological estimates. The newly revised biochronology for the sequence is

consistent with the earliest Biharian corresponding to the later phases of Odessian small-mammal assemblage, which suggests a date of between 1.5-1.8 Ma, older than previously estimated based both on large and small mammals (Tchernov 1988).

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The Last Glacial Maximum sequence of Grotta della Ferrovia (Fabriano, Ancona, Italy). Direct radiocarbon dating and genetic studies on small mammals to detect and describe the chronology of the past climate oscillations.

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Abstract

Grotta della Ferrovia (Fabriano, Ancona, Italy, 40°25'36''N, 13°0'11''E, 215 a.s.l.) is a small cave that opens on the southern bank of the Esino river, around 45 km west of Ancona. Discovered in 1966, it is famous among scholars because it is the first locality where the fossil *Sicista* was recorded in Italy (Bartolomei, 1966) and because the lithic assemblage found in the cave was related to the Late Epigravettian (Broglio and Lollini, 1981).

Recent developments in paleoenvironmental and paleoclimatic reconstructions, collagen extraction of small samples and ancient DNA analyses led us to review the fossil small mammals published by Bartolomei and Cattani (2005) in order to verify the reliability of the sequence and detect if the assemblage changes can be related to global climatic shifts.
Along the sequence, divided into seven layers (from GDF7 to GDF2), two main phases can be recognised: in the first one, from GDF7 to GDF5, *Microtus arvalis* is dominant over *Microtus agrestis*, in a poorly diversified assemblage. The sequence gradually changes in GDF4 and a second phase can be observed, represented by GDF3 and GDF2, where *Apodemus* gr. *sylvaticus-flavicollis* dominates, but combined with a higher number of taxa. From GDF7 to GDF3, few individuals of *Sicista* cf. *subtilis* and *Alexandromys oeconomus* are recorded. Environmental and climatic reconstructions calculated with the Habitat Weighting and the Bioclimatic methods show a dominance of open meadows (GDF7 to GDF4) that were gradually replaced by closed or semi-closed forests (GDF3 and GDF2) in a context of gradually increasing temperature, going from a cold phase to conditions similar to the current ones in the Grotta della Ferrovia area.

Direct radiocarbon dates on 18 rodent bones and aDNA analyses on three *Microtus arvalis* teeth helped us to better understand the significance of the oscillation inferred from the small mammal sequences. A robust series of 9 radiocarbon measurements from GDF7 to GDF5 shows that this part of the sequence accumulated between ~24,600 - 19,600 cal BP (95.4% probability), which includes the final phases of the Last Glacial Maximum. The ancient DNA from *Microtus arvalis*

confirmed the chronological framework and the presence of italic populations in this area during the LGM, similar to the slightly more ancient Grotta del Sambuco on the western side of the central Peninsula. The small mammal radiocarbon dates from GDF4 and above are less consistent with

their stratigraphic position, probably related to reworking of the sediment, but suggest the last part of the sequence accumulated during the Late Glacial.
Our results show that it is now possible to check the validity and enhance paleoclimatic and paleoenvironment inferences from the small mammal sequence studies with direct radiocarbon dates and ancient DNA analyses, using these integrated methods as a high resolution tool for studying the past.

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The environmental conditions in northern Iberia during Middle-to-Upper Paleolithic transition based on the small mammals' record

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Abstract

Small-mammal assemblages are proxies commonly used to explore the terrestrial paleoenvironment during the Pleistocene. The synchronic accumulations of these remains and human activity remains on archaeological sites also allow characterization of the climate experienced by past human populations. In this work we present a complete compilation of the small mammal studies undergone so far in northern Iberia corresponding to the Late Pleistocene and focusing on the transition from the Middle to Upper Paleolithic to evaluate the climatic causality on Neanderthal decay, main aims of the ongoing ERC SUBSILIENCE project.

This region is a key area because it constitutes one of the main pathways for the arrival of anatomically modern human populations into Iberia. The employed dataset includes a total of 80 levels containing high-quality small mammal data coming from 17 different archaeo-paleontological sites, extending from 55,000 to 25,000 years, and including late Mousterian, Châtelperronian, Aurignacian and Gravettian levels. In these assemblages, the most common species have Euro-Siberian climatic requirements (*Microtus arvalis/agrestis, Talpa europaea, Arvicola amphibius*), whereas Mediterranean species (*Microtus (Terricola) duodecimcostatus, Microtus cabrerae*) are scarcely present, and the abundance of woodland dwellers (*Apodemus sylvaticus/flavicollis*) oscillates. Based on the habitat weighting method, humid meadows are underlined as the main landscape type, in combination with open forest, grassland and punctual dry shrubland. The landscape composition appears homogeneous over time based on small-mammal communities. Nevertheless, the species spectra of each sedimentological unit, calculated through the Bioclimatic Model method, allows for a paleoclimatic estimation of past temperatures and precipitation amounts.

The results suggest colder and drier conditions in respect to modern baselines, with a decreasing trend in rainfall and temperatures from the Middle to Upper Paleolithic, especially between the GS13 (48,000 cal BP) and GS12 (44,000 cal BP), coincident with late Neanderthal occupations followed by a populational hiatus. These results must be taken cautiously considering the scarcity of small mammal remains, the age and methods of excavation utilized, the limited taphonomic analyses available for some assemblages, as well as the fact that certain taxonomic aggregations could hide environmental information. Nevertheless, the main conclusions are in line with other regional climatic proxies, such as pollen, stable isotopes on large mammals, and glacial records which suggest colder and drier conditions at the end of the Middle Paleolithic in the region.

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El Mirador cave (Late Pleistocene to Holocene): a key locality for understanding the extant configuration of Iberian bats

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Abstract

The Late glacial to Holocene transition is a key moment for understanding the configuration of extant bat populations in the Iberian Peninsula (IP), but a poorly known period regarding the Iberian fossil record of order Chiroptera (Galán 2019). Here we describe and contextualize the association of fossil bats through the sequence of El Mirador cave (Sierra de Atapuerca, Burgos, Spain). The site chronology ranges from Late Pleistocene (layers MIR51/2 and MIR51/3, late Magdalenian) to Middle Holocene (layers MIR24 to MIR6, Neolithic) and Late Holocene (layers MIR4 and MIR3, Middle Bronze Age; Vergès et al. 2016). The MIR49 layer, where the accumulation is related to nocturnal birds-of-prey activity, has provided the richest fossil bats assemblage from this chronology in the region.

14 bat taxa have been identified through the sequence, all of which are present in layer MIR49 (the richest level in terms of bat remains and bat species) and constituent of the extant Iberian faunas (Dietz et al. 2009): *Rhinolophus ferrumequinum, Rhinolophus mehelyii, Myotis daubentony, Myotis nattereri, Myotis bechsteinii, Myotis myotis, Myotis blythii, Nyctalus noctula, Nyctalus lasiopterus, Pipistrellus pipistrellis, Eptesicus serotinus, Barbastella barbastellus, Plecotus austriacus* and *Miniopterus schreibersii*.

The recorded bat association in MIR49 (estimated age between 13.18-13.42 ky calBP [MIR51/2; Vergès et al. 2016] and 7.33-7.13 ky calBP [MIR23; Vergès et al. 2016]) has no current equivalent in the IP or in Europe (Dietz et al. 2009). The exceptional bat diversity in MIR49 likely reflects a set of special environmental features including relatively humid conditions together with mild temperatures. Furthermore, this layer was deposited when anthropogenic modification of the surrounding landscape was low, and the cave was not occupied by humans. Comparatively, the overlaying Holocene layers have provided a very small amount of bat remains. Only a maximum of two species per layer are recorded through this section, mostly *M. myotis/M. blythii* and *M. schreibersii*. The abrupt disappearance of many species represented in MIR49, which includes those with a moderately high representation such as *M. bechsteinii* and *M. nattereri* (9% of the bats in MIR49 each species, the most abundant species *M. blythii* representing the 29%), together with the persistent continuity of only two taxa, can be interpreted as a general drift in the local bat faunas during the Middle Holocene towards becoming less diverse, more similar to the current ones. Whether this phenomenon is related only to environmental changes (increase in open landscapes) or also to anthropic activity should be tested on other synchronous sites in absence of human presence. Finally, the *M. blythii* record coeval with *M. myotis* in MIR49 provides solid evidence of the presence of this Eastern European species in the IP in a time frame between 13

and 7 ky BP, earlier than previously established and soon after a general expansion of open landscapes with arid-related vegetation (the main habitat preference of *M. blythii*, Dietz et al. 2007) related to Heinrich Event 1.

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Confirming the sub-tropical paleoecology of Yahuai cave in Guangxi, China at 120 kya through the identification of rodent remains

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Abstract

It is hypothesized early modern humans could not penetrate the rainforest to forage for food, due to the lack of protein sources, and that this ability only evolved later in human evolution ca. 40 kya (Scerri et al., 2022). According to this hypothesis, early modern humans dispersing from Africa to Asia ca. 120 kya would have preferred savanna over tropical environments. The analysis of small mammal remains is significant in this debate because of the ability to infer, by way of their habitat preferences, the paleoecology of the area and paleoecological reconstruction comparisons across space and time.

As a case study we present a diachronic study of Rodentia remains from Yahuai Cave, Guangxi, China, found near several contemporaneous sites with early human remains, such as Tongtianyan and Mulan cave. Yahuai cave is located 100 km northwest of Nanning in Long'an County, Guangxi Zhuang autonomous region, China. The site has a total area of more than 100m^2 and is made up of an inner cave and rock shelter. It was excavated between 2015 and 2018 by the Guangxi Institute of Cultural Relic Protection and Archaeology (Wu et al., 2020). Sieving and flotation methods were used to collect remains.

This research focuses on Area A of the site, located near the back of the rock-shelter which revealed a large fossil assemblage. Area A deposits are over 7m thick, with 53 stratigraphic layers divided into 2 units and dated using six OSL dates (Peking University). Unit 1 comprises layers 10-53. Layer 14 is dated to 101.6±24.1 ka BP while layer 53 is dated to 124.2 ±16ka BP. Unit 2 comprises layers 1-9 with layer 7 dated to 42.4±3.6 ka BP while layer 9 is dated to 55.7 ±7.4 ka BP.

The analysis of small mammal fossils in the region has been an underutilized method in paleoecological reconstruction. Thus, this research will help bolster other lines of paleoecological evidence at a site as well as highlight the need for this methodology and the preservation of these small fossils for future research.

Species found include a wide range of murids such as *Niviventer andersoni* (Anderson's white-bellied rat), *Mus pahari* (Gairdner's shrewmouse) and other murid specimens identified only to the genus level, such as *Leopoldamys*, *Rattus* and additional species of *Niviventer*. Other species include several squirrel species such as *Hylopetes alboniger* (Particolored flying squirrel), and *Belomys personii* (hairy-footed flying squirrel).

The paleoecological analysis utilizes the ecological analogy and community structure analysis method which indicates a warm, humid, dense forested environment, probably more humid than the contemporaneous Indochinese peninsula. There are also no appreciable differences in species

composition across strata suggesting the ecology of the area was similar in the lower strata, ca. 120 kya, to that in the upper levels, ca. 40 kya. This finding, alongside the finding of early hominin remains nearby (Jin et al, 2009), confirms the ability of early modern humans to utilize this novel ecosystem earlier than previously assumed.

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New Gelasian small vertebrate assemblage from northeastern Iberia: chronological and environmental remarks

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Abstract

Here we present the chronological and environmental results of the small mammal assemblage recovered from a disappeared karstic fissure located in a quarry called "Pedrera del Corral d'en Bruach". The site was located at 330 m. a.s.l. in the Garraf Massif near to the Gavà town at c.a. 20 km to south of Barcelona. The site was discovered and first excavated by Joaquim Guillén and published as a Canal Negre-1. A rescue archaeological excavation was conducted in 2006 by Grup de Recerca del Quaternari focused on sieving the sediments accumulated at the foot of the quarry face. Fortunately, some faunal remains and sediment were recovered, which were later processed and sorted, where a considerable amount of small mammal remains appeared (Daura et al. 2007-2009).

Considering this context, the main objectives with the small mammal studies was to perform a chronological and environmental approach of the site. About 100 small mammal remains recovered have been identified at genus or species level, highlighting a great diversity in the association. Among these, at least five insectivores have been identified (*Talpa* sp. 1, *Talpa* sp. 2, *Beremendia fissidens*, *Petenyia hungarica*, and *Deinsdorfia* cf. *doukasi*), one bat (*Rhinolophus* gr. *ferrumequinum*), one lagomorph (*Prolagus* cf. *calpensis*) and ten rodents (*Apodemus atavus*, *Apodemus jeanteti*, *Castillomys rivas*, *Stephanomys balcellsi*, *Glis minor*, *Eliomys intermedius*, *Glirulus* cf. *pusillus*, *Muscardinus* cf. *avellanarius*, *Allocricetus* sp. and *Mimomys medasensis*). According to Sesé (2006), the association of the water vole species *M. medasensis* together the mice *Apodemus* spp., *C. rivas* and *S. balcellsi*, the pika *P. calpensis* and the dormouse *E. intermedius* is typically from the Mammalian Neogene 17 (MN 17) biozone in the Iberian Peninsula. This would place the "Pedrera del Corral d'en Bruach" in the Gelasian stage of the Early Pleistocene with an age between ca. 2.6 and 1.8 Ma.

In accordance with the identified small mammal assemblage and the chronological framework, the environment during the first part of the Early Pleistocene in the surroundings of the Garraf Massif

was characterized by open forest landscape (indicated in general by the presence of murids *Apodemus* spp., *C. rivas* and *S. balcellsi* and the glirids *G. minor, E. intermedius, G.* cf. *pusillus*, *M.* cf. *avellanarius*), and a more humid environment (indicated in general by the presence of insectivores of genus *Talpa* and the red-toothed shrews *B. fissidens, P. hungarica* and *D.* cf. *doukasi*) than the current one (Solís et al. 2000) with stable water streams in the vicinity of the site (indicated mainly by the presence of the water vole *M. medasensis*). Such interpretation is supported by the presence in the site of a rather diverse assemblage of amphibians and reptiles, also indicating more humid local conditions than today in the area (Albanerpetontidae indet. and *Blanus* sp.), together with taxa typically associated to open-dry area and Mediterranean woodlands (cf. *Pelobates cultripes*, Agamidae indet., *Pseudopus* sp., and *Zamenis scalaris*).

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The small-mammal record from the Aceramic Neolithic tell site of Chogha Golan (Iran): paleoenvironmental and archaeological implications

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Abstract

Here we present the first results of the taxonomic and taphonomic analysis of the small-mammal remains recovered from the Aceramic Neolithic tell site of Chogha Golan (Ilam Province, Iran). The site (N 33.223850º, E 46.161593º) is located at an altitude of 485 m.a.s.l., in the foothills of the Zagros Mountains, and it was excavated by the Tübingen-Iranian Stone Age Research Project team in collaboration with the Iranian Center for Archaeological Research between 2009 and 2010. The high-resolution bioarcheological record from Chogha Golan spans between 12,000 and 9,600 cal BP and is key for our understanding of the emergence of agriculture and husbandry practices at the Hilly Flanks of the Eastern Fertile Crescent. Currently, Chogha Golan represents the earliest record of plant management in Iran, and it includes evidence of the appearance of morphologically domesticated-type emmer wheat (*Triticum dicoccum*) by 9,800 cal BP.

The small-mammal assemblage of Chogha Gholan consists of two gerbilline and two murine species, along with some indeterminate chiropters and insectivores. The most abundant taxon is Indian gerbil (*Tatera indica*), followed by short-tailed bandicoot-rat (*Nesokia indica*). We have also documented the presence of Persian jird (*Meriones* cf. *persicus*), and house mouse (*Mus* cf. *musculus*), but they are uncommon in our assemblage. On the basis of their habitat preferences and requirements, the small mammals indicate that the surrounding landscape of the site was characterized by warm, arid conditions and grasslands, but with some humid areas and/or permanent water bodies nearby. Nowadays, the Indian gerbil and the short-tailed bandicoot-rat mainly inhabit cultivated fields. The taphonomic analysis shows that the majority of the small-mammals recovered at Ghogha Golan do not present evidence of digestive corrosion. Moreover, rodent gnawing on ungulate specimens also confirms the presence of live rodents at the site, which might have been attracted by the available resources derived from food storage and waste. Although the long-term co-evolutionary history of murids and humans during the Late Pleistocene-Early Holocene is not yet well-understood, we suggest that the overrepresentation of Indian gerbil in our assemblage most likely was the result of the new ecological dynamics created by settled human communities and niche construction activities. Therefore, the small-mammal record from Chogha Golan not only supports previous paleoenvironmental reconstructions drawn from archaeobotanical and large-mammal studies, but it also provides new insights on the ecological transformations and socio-economic changes that took place in the foothills of the Zagros Mountains of Iran at the onset of Neolithic lifeways.

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Mid-European small mammals during the Early/Middle Pleistocene Transtition

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Abstract

The stage of the Early Middle Pleistocene Transition (EMPT) presented undoubtedly one of the most distinct turning point in the Late Cenozoic history. Here we report results of re-examination of a rich fossil record of that time obtained from a series of sites in the Czech Republic.
In total we analysed 64 community samples of small ground mammals (MNI>15) recognizing 45 phenotypically distinct taxa. Total abundance of the set was 13995 MNI, mean sample abundance was 218.7 MNI. In all, the community structure both in terms of species composition and dominance structure was in general quite similar. Axial structure of a community was formed by few species which appear as euconstant elements of the total sample: *Microtus hintoni-gregaloides* (appearing in 76% of samples), *M. arvalinus* (73.4%), *M. arvalidens* (71.8%), *Mimomys savini* (68.5%) *Clethrionomys* sp. (65.6%), *M. coronensis* (62.5%), *M. ratticepoides* (60.9%), *M. nivaloides* (51.6%), *Talpa minor* (50%) and *Sorex runtonensis* (46.9%). Further three taxa appeared in more than 25% samples (*Drepanosorex savini, Apodemus* sp., *Pliomys episcopalis*) while 24 species occurred in less than 10% of samples only. *M. hintoni-gregaloides* was far the most significant component of the dominance structure in 50 samples. Its dominance in total material was 52.4%, its mean dominance in particular samples was 38%. Also *M. arvalinus* with 10.2% rank among the eudominant elements. The dominant elements (5-10%) were *M. arvalidens, Sorex runtonensis, Clethrionomys* sp. and *M. ratticepoides*.
Yet, particularly in the earlier section of the covered period (MIS 22-17), the community samples exhibited an increased species diversity due to regular appearance of diverse recedent and subrecedent elements including those which can be considered index species of EMPT period (*Macroneomys brachygnathus, Petauria voigtstedtensis, Dicrostonyx simplicior, Lagurus transiens, Spermophilus dietrichi*). LAD *Beremendia fissidens* and FAD *Sorex minutissimus, Lemmus/Myopus, Pteromys volans, Neomys newtoni* or *Sicista subtilis* in that time are also worth of mentioning.

A synoptic survey suggests for a history of the EMPT fauna in Central Europe the following picture: (i) establishing the axial community structure (perhaps during glacial stages MIS 22 or earlier), (ii) enriching community structure by appearance of novel recedent elements including alien distant immigrants during subsequent stages MIS 21-17, (iii) reduction of diversity during the glacial stages terminating Q2 stage of Late Biharian (MIS 16) and subsequent climatic cycles forcing the phenotype rearrangements of resident taxa (*M. gregaloides - gregalis* etc.).

Such a view is also supported by results of analyses of bat assemblages (MNI=905) which dominance structure is quite homogenous with eudominant elements of *Myotis bechsteinii, M.nattereri, Plecotus auritus, M.* cf. *mystacinus* and *M. emarginatus*, yet - particularly in the earlier stages - it is attributed by a number of subdominant and recedent elements (such as *M. brandtii, Barbastella* sp., *Eptesicus serotinus, E. nilssoni* etc.) including those now missing in the region (*M. schaubii, R. ferrumequinum, Miniopterus schreibersii*).

Small vertebrates from the level QS-3 from the site of Quibas (Early Pleistocene, Murcia, Spain)

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Abstract

The site of Quibas (Murcia, Spain) is a karstic complex of cavities filled by sediments of early Pleistocene age. The main structures of this complex with paleontological record consist of a gallery called Quibas-Cueva and a vertical shaft known as Quibas-Sima. The Quibas-Sima sequence contains seven distinct detritic units: QS-1 to QS-7. The upper units QS-5 and QS-6 yielded no fossils other than gastropods, while all the underlying units and the uppermost one contained as well vertebrate remains. The lower units of the sections (QC-1 to QC-5 and QS-1) show a reversed polarity ascribed to the pre-Jaramillo Matuyama (1.2 – 1.07 Ma), whereas the intermediate units (QS-2 to QS-5) bear a normal polarity directly linked to the Jaramillo subchron (1.07 – 0.99 Ma). Finally, the upper units record post-Jaramillo reversed polarity (0.99 – 0.78 Ma). The Quibas sequence, therefore immediately post-dates the oldest hominin record in the early Pleistocene of Europe, as represented at the sites of Barranco León, Fuente Nueva 3 (both in the Guadix-Baza Basin) and Sima del Elefante (Atapuerca karstic complex) (Piñero et al. 2020, 2022). Along the Quibas-Sima sequence (QS-1 to QS-7), a very complete small vertebrate succession has been reported, including amphibians, squamate reptiles, chelonians as well as mammals, represented by insectivores, bats, rodents and lagomorphs. This work presents the preliminary results on the taphonomy obtained from the small-mammal fossil record of the unit QS-3 from the section of Quibas-Sima. Among the more than 620 recovered remains, 11 small mammal species have been identified, including shrews (*Crocidura kornfledi*), hedgehogs (*Erinaceus* sp.), bats (*Rhinolophus ferrumequinum*, *Myotis nattereri*, *Myotis myotis*), rodents (*Manchenomys orcensis*, *Apodemus sylvaticus*, *Castillomys rivas*, *Eliomys quercinus*) and lagomorphs (*Oryctolagus* cf. *giberti*, *Prolagus calpensis*), as well as squamate reptiles such as lizards (*Blanus cinereus*) and snakes (*Vipera latastei*, *Coronella girondica*, *Malpolon monspessulanus*). The karstic nature of the site and the low presence of digested remains 9% of teeth suggest that the accumulation is mainly scatological in origin, with the possible influence of predators such as the owl *Athene noctua*, *Otus scops* and *Strix aluco*, all identified at Quibas. To a lesser degree, diurnal birds of prey and mammalian carnivores may also be involved in the scatological accumulation from QS-3. The ecologic preferences of the identified taxa suggest the prevalence of rocky areas and shrublands, together with some woodland isolates. These conditions point to the existence of a woodland mosaic on the Sierra de Quibas at the base of the Jaramillo subchron. The absence of flying-squirrels (*Hylopetes* sp.) and aquatic shrews (*Neomys* sp.), both associated to forest and water flows and present at the lower levels of the Quibas-Sima section, suggest a trend towards increasing arid conditions from the base of the section to the QS-3 level, forest being replaced by open woodland and shrubs.

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A new Early Pliocene vertebrate site from the Duero Basin (central Iberian Peninsula)

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Abstract

Here, we introduce the new vertebrate site of La Piquera (Duero Basin, central Iberian Peninsula) by presenting a preliminary faunal list. The faunal diversity and abundance of La Piquera is extraordinary. Among the material, there are representatives of urodeles (Salamandridae), anurans (Alytidae, Pelodytidae, Bufonidae), lizards (Agamidae, Lacertidae, Anguidae, Scincidae, Blanidae), snakes (Boidae, Colubridae), artiodactyls (Bovidae), insectivores (Soricidae, Erinaceidae), bats (Vespertilionidae, Rhinolophidae, Megadermatidae), rodents (Cricetidae, Gerbillidae, Muridae, Gliridae, Sciuridae) and lagomorphs (Leporidae, Ochotonidae). The faunal assemblage suggests a basal, Early Pliocene age, lower part of the MN14 unit (early Ruscinian), with the presence of *Myosorex meini*, *Debruijnimys* sp., *Castillomys gracilis*, *Stephanomys dubari*, *Apodemus gorafensis*, *Paraethomys meini*, *Occitanomys alcalai*, *Apocricetus* cf. *barrierei* and *Ruscinomys lasallei*, among others. The new locality has an intermediate biostratigraphic position between the sites of Sifón-413 (at about 5.33 – 5.23 Ma; Piñero and Agustí 2019) and Botardo-D (between 4.79 and 4.63 Ma; Piñero and Agustí 2020). The ecological affinities of the identified small vertebrates suggest the presence of a landscape dominated by open herbaceous meadows in central Spain during the earliest Pliocene, with the occasional presence of woodland patches and stable water bodies under relatively dry and warm environmental conditions. La Piquera, therefore, enhances our knowledge on the association of fossil vertebrates recorded in the central Iberian Peninsula during the basal Pliocene. With more than 1200 remains, the La Piquera collection represents the richest sample of small vertebrates from the beginning of the Pliocene documented to date in the Iberian Peninsula. Thus, it becomes a key locality for the Early Pliocene of Southwestern Europe, in a region, central Spain, where this time span is poorly represented (Luengo et al. 2009).

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Exotic taxa do matter: the herpetofaunal assemblages from the Early Pleistocene sites of Barranco León and Fuente Nueva 3 (Granada, Spain)

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Abstract

The Early Pleistocene archeopaleontological sites of Barranco León and Fuente Nueva 3 (Granada, Spain), dated respectively to 1.4 and 1.2 Ma, have yielded a rich micro- and macro-vertebrate assemblages. The faunal list of amphibians and reptiles in both sites is composed by a total of 14 species: seven anurans (*Discoglossus* sp., *Pelobates cultripes*, Bufonidae indet., *Epidalea calamita*, *Bufotes viridis* s.l., *Hyla* sp., and *Pelophylax* cf. *perezi*), two lizards (an indeterminate large-sized lizard and *Ophisaurus* spp.) and five snakes (*Malpolon monspessulanus*, *Natrix maura*, *Natrix natrix* s.l., cf. *Coronella* sp. and *Zamenis scalaris*). Here, new stratigraphically constrained quantitative climatic data for the Barranco León and Fuente Nueva 3 sites are reconstructed on the bases of their herpetofaunal assemblages considering, for the first time, the exotic taxon *Ophisaurus* spp. For this purpose, we have applied an improvement of the Mutual Ecogeographic Range method by projecting the niche envelope of their extant representatives: *Hyallosaurus koellikeri* and SE Asian *Ophisaurus* spp. To do so, we have first modelled their ecological niche by analyzing and extracting the ecological variables that best explains their current distribution.

Then, following the basis of the Uncertain Distribution Area – Occupied Distribution Area discrimination technique, we have projected their niche envelope over the resulted overlapping areas of the Iberian Peninsula in order to remove the areas where those taxa would not have been able to survive. This new procedure represents an advance in the paleoclimatic reconstructions based on microvertebrates, due the fact it allows us to take into account in the analysis taxa currently absent from the examined geographical extension, providing consecutively more accurate data. We obtained differences in temperature and rainfall between the different layers of the two sites, in line with previous reconstructions that allowed the identification of warm and humid periods ('interglacial') in Barranco León, as well as more temperate but drier periods ('glacial') in Fuente Nueva 3. Our results shed light on the Early Pleistocene climate cyclicity, and open the path to go deeper into the paleoclimatic and paleoenvironmental reconstructions based on small vertebrates, enabling us to include the exotic taxa in the analyses.

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