96th Annual Meeting of the German Society for Mammalian Biology

Universität Zürich[UZH]

Program and abstracts

UZH alumni

Friday 25 of August, Central campus, Zoology/Palaeontology Museum KO2

13:15–15:00	Independent event, open to all	Pre-DGS symposium on Explorers in South America, KO2-F-174 for program see here

17:00–18:00	Curators meeting	Lecture room KO2-E-72a
17:00	Registration	Outside KO2-E-72a
18:00	Welcome address	Marcelo Sánchez-Villagra—Zoology Museum Cinema
18:20	Evening lecture	Regan Dunn: Palaeoecology and extinction—Zoology Museum Cinema
19:00–21:00	Icebreaker (Apéro Riche)	Zoology Museum

Saturday 26 of August, Irchel campus, Y24-G-45

08:00		Registration open
08:00		Posters to be placed
08:30		Conference opening: Marcelo Sánchez-Villagra and Marcus Clauss
08:45	Plenary I	Alexandra van der Geer: Evolution on Islands
	Morning session	Chair: María J. Duque-Correa
09:30	Heckeberg	Controversies concerning cervid systematics, antler tine homologies, and the special case of *Elaphurus davidianus*
09:45	Hempel	Insights into the evolutionary history of the extinct blue antelope
10:00	Carrillo	Contrasting diversity and disparity patterns in a continental radiation: diversification and morphological evolution in caviomorph rodents
10:15		Coffee break
10:45	Kissling	The shape and allometry of the brain and inner ear of the Steller's sea cow
11:00	Studer	Are bear-dogs morphologically similar to bears and/or dogs? A preliminary morphological analysis of their cranial system during the Cenozoic
11:15	Le Verger	The mammalian knight: when evolution leads to armor and weaponry.
11:30	Plenary II	Analia Forasiepi: Extinction in deep time
12:15		Lunch Break (lunch provided)
13:15	Plenary III	Vera Weisbecker: Life history evolution and evo-devo
	Afternoon session	Chair: Ana Balcarcel
14:00	Rössner	Bone microstructure and histology: unravelling the evolutionary history of the antler cycle
14:15	Flores	Evolutionary patterns in cranial growth in sigmodontines (Rodentia, Cricetidae)
14:30	Herrel	Ontogeny and growth of the locomotor muscles in primates: impact of developmental strategy.
14:45		Coffee break
15:15		Poster session
16:00	Segura	Evolution of cranial ontogeny in felids (Carnivora: Felidae)
16:15	Wirkner	Some tigers may be lion to you – morphology and morphometry of the first lower molar in Pantherinae
16:30	Schulz-Kornas	A comprehensive overview of wear analysis in life history evolution
16:45	Plenary IV	Richard Madden: Life history evolution and mammalian teeth
17:30		DGS general assembly
19:00		Brown bag (provided) at Irchel Park

Sunday 27 of August, Irchel campus, Y24-G-45

08:00		Registration open
08:45	Plenary V	Monica Bond: Life history and extinction risk in a large mammal
		Chair: Aldo Benites-Palomino
09:15	Decher	Diversity of small mammals in the International Park Lower Oder Valley
09:30	Appleby	Douglas fir and Norway spruce have similar effects on small mammal density, but not survival, in Central European managed forests
09:45	Duque-Correa	Seasonality and mammalian intestinal length: where life history meets anatomy
10:00	van Heteren	Seasonal bone microstructure fluctuations in *Sciurus vulgaris fuscoater* humeri: a case study using phenomics on CT-scans
10:15		Coffee break
		Chair: Kévin Le Verger
11:00	Amson	Fur glowing under UV and porphyrin accumulation in skin appendages.
11:15	Stein	Impact of local and landscape scale effects on the occurrence of the common hamster (*Cricetus cricetus*) in a simple agricultural landscape
11:30	Perea-García	Exploring drivers of external eye appearance in macaques
11:45	Rothier	Unravelling the adaptive landscape of limb morphology in mammals: The role of locomotor modes
12:00	Yuan	Anatomical innovation in the evolution of shrews (Soricidae, Lipotyphla)
12:15		Lunch break (lunch provided)
		Chair: Valentina Segura
13:15	Montoya-Sanhueza	What the appendicular anatomy of African mole-rats (Bathyergidae) can tell us about their evolution?
13:30	Süess	Comparative colony dynamics and genetics of the highveld mole-rat, *Cryptomys hottentotus pretoriae*, and the Mahali mole-rat, *C. h. mahali*
13:45	Damman	Are ageing and longevity linked to sociality in African mole-rats (Bathyergidae)?
14:00	Malkemper	Behavioral and histological investigations of the magnetic sense in subterranean mole-rats
14:15	Arnold	Four-toed sengi (*Petrodromus*, Afrotheria) museomics reveals the crucial role of East African forests in macroscelidean diversification
14:30		Coffee break
		Chair: Kimberley Kissling
15:15	Schai-Braun	Reproductive performance in the European hare (*Lepus europaeus*): are maternal body conditions decisive?
15:30	Caspar	Funky gibbons: Probing into the dance displays of small apes (*Nomascus* spp.)
15:45	Benites-Palomino	A new pygmy sperm whale from Peru broadens the limits of cranial asymmetry
16:00		Fritz-Frank-award talk
16:45		Conference closing
17:00		Social Event youngDGS

Monday 28 of August, Central campus, Zoology/Palaeontology Museum KO2 and other locations

8:30–14:00	Workshop on Imaging and 3D data by Vera Weisbecker, information to be provided
8:30–14:00	Excursion to Mammoth Museum

Practical Information

Internet

Most universities and research institutions use **eduroam**. Members of such institutions have Internet access in the public areas of UZH via the eduroam WLAN network. We recommend testing eduroam access at your home university in advance to ensure that the configuration is correct.

As a guest at UZH, you can access the Internet everywhere where there is WLAN access: Simply select the **uzh-guest WLAN** network. After doing so, accept the Terms of Service and fill in the registration form with your mobile phone number. You will subsequently receive an access code by text message, which allows you to unlock Internet access.

Cash

Those that were not able to send a bank transfer, we ask you to please pay in cash upon your arrival. Unlike us, many places accept cards, but do not be surprised if some do not. It may be a good idea to have some Swiss Francs at hand. Please approach any members of the host committee (easy to recognize by their green conference tags) if you need help locating the closest ATM. There are several options at the main train station and airport to change from EUR to CHF.

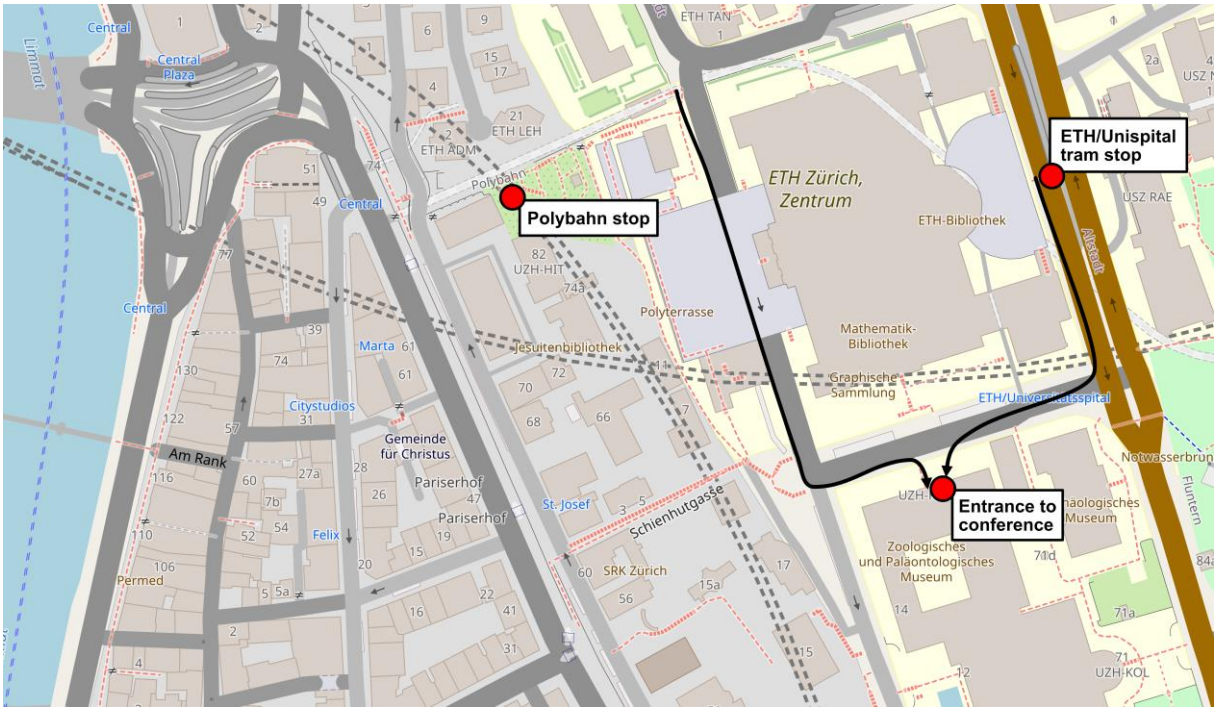
Submitting your presentation

There will be a laptop at the welcome desk where you can upload a copy of your talk. Those giving a talk on Saturday morning are kindly asked to hand them in on Friday evening. All others please make sure you hand in the file to the chair of your session during the breaks at the latest (see program). The posters need to be placed on Saturday at 8:00, please look for your name on the poster wall (important for the Marzipan contest!), the poster “Marzipan code” is also shown below for each abstract. Tacks to hold posters will be provided.

Navigation

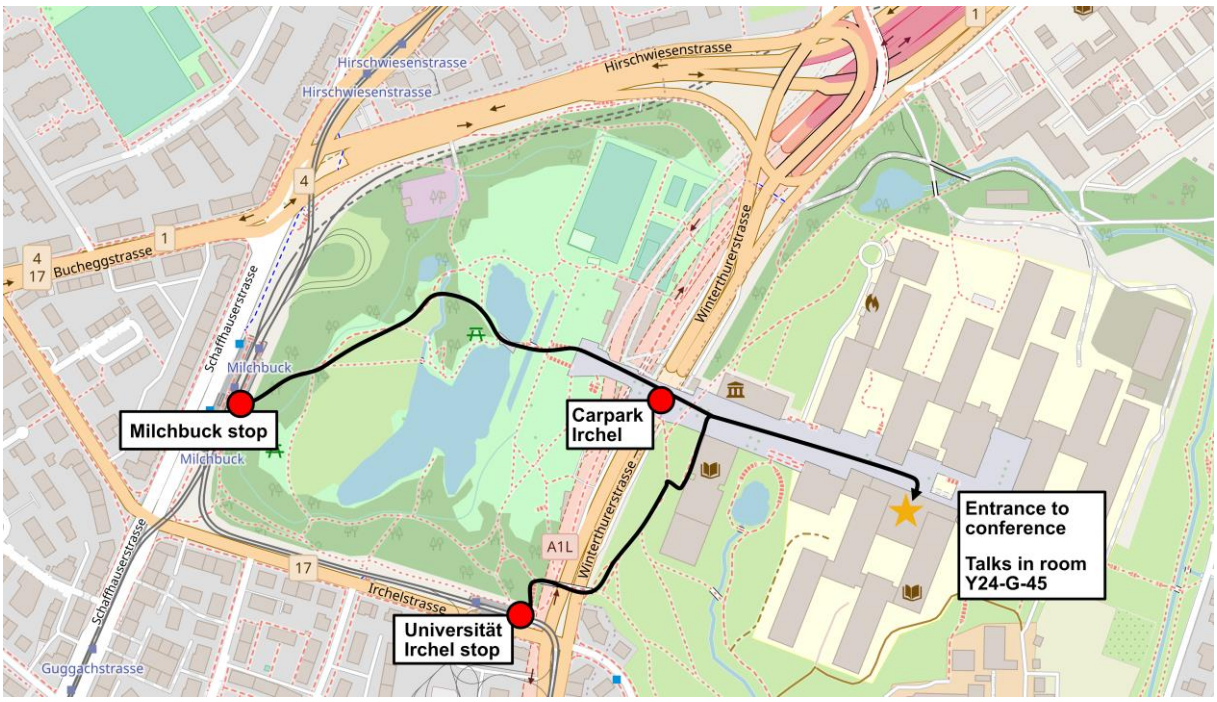
We recommend using **public transport**. Find below two maps with details on how to get to the conference from the closest tram stops. If you come **by car**, please inform yourself on parking options (e.g., see this link); the city centre (for Friday) is particularly challenging. At Irchel (Saturday and Sunday) there is a large parking lot (it costs 3.5 CHF the first hour and then 3 CHF per hour). If you park here, we recommend you to take the lift to floor F and follow the route shown below in the map below.

Map Central campus (Friday)



Address: Karl-Schmid-Strasse 4, 8006, Zurich

Map Irchel campus (Saturday and Sunday)



Winterthurerstrasse 190, 8057 Zurich

Excursion to Mammoth Museum

We offer an excursion to the Mammoth Museum for a guided tour on Monday 28.08. The places are restricted to a maximum of 20 participants, so please send an email to registration_dgs2023@pim.uzh.ch with the subject “Mammoth Museum” and a short note to secure your place and better plan the logistics. If number of participants is too low, we will have to cancel. The deadline to register for this is Tuesday 22.08.

We are traveling by train; the museum is 30 minutes away from Zurich’s main station and the only cost for this activity is the price of the round train ticket (about 25 CHF)

Meeting place and time: Zürich main station, meeting point for groups (Gruppen-Treffpunkt). We meet on **28.08. at 8:10 am.** Please be there on time, we will leave shortly afterwards!

The tour and visit to the museum are planned to take 90 minutes, so we will be back at Zurich main station by noon.

Alphabetical order, by first author, presenting author underlined

TALK

Douglas fir and Norway spruce have similar effects on small mammal density, but not survival, in Central European managed forests

Scott M Appleby[1], Niko Balkenhol[1]

[1]*University of Göttingen, Wildlife Sciences, Büsgenweg 3, 37077 Göttingen, Germany*

In an effort to ameliorate the impacts of climate change, forest managers in Central Europe increasingly turn to conifer species that produce higher yields and are better adapted to projected future climatic conditions. Though small mammals are an important component of the forest ecosystem, the impacts of enriching native broadleaf forests with conifers on small mammal communities are not well understood. We conducted mark-recapture surveys of small mammals to ascertain differences in their community structure among stands of two conifers (native Norway spruce *Picea abies* and non-native Douglas fir *Pseudotsuga menziesii*) and the dominant broadleaf in the region, European beech (*Fagus sylvatica*). After estimating the density of two common species, the yellow-necked mouse *Apodemus flavicollis* and bank vole *Myodes glareolus*, we found that the population density of each is positively related to the proportion of beech and negatively to the proportion of conifers in each stand, though these effects of stand composition are smaller than the positive effect of vegetation cover. Increasing Norway spruce proportion reduced monthly survival of small mammals, while Douglas fir proportion had a positive effect on survival. We conclude that the two conifer species have similar impacts on small mammal density, though overall small mammal survival was significantly lower on plots with Norway spruce. This suggests that increasing the proportion of Douglas fir at the expense of Norway spruce may be possible without significantly changing local patterns of small mammal population density, but further research is necessary to elucidate the exact impacts of these two conifer species on small mammal demography and behavior.

TALK

Four-toed sengi (*Petrodromus*, Macroscelidea, Afrotheria) museomics reveals the crucial role of East African forests in macroscelidean diversification

Patrick Arnold[1], Justus Hagemann[1], Luis Victoria Nogales[1], Michael Hofreiter[1]

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Sengis or elephant shrews (Macroscelidea) are small African mammals, with most species inhabiting arid regions. The four-toed sengi (*Petrodromus tetradactylus*), however, roams diverse habitats from coastal and Afromontane forest, to Zambezian woodlands and savannahs, to Congolian lowland forest. It has one of the largest geographic ranges of all sengis, but this is divided into two allopatric areas. Although monotypic, *Petrodromus* shows some morphological variation across its geographical distribution that has historically led to the erection of numerous forms, subspecies and (later abolished) species, with rivers often considered as separating different taxonomic groups. Within this project, we aim to revise the phylogenetic, taxonomic and biogeographic history of this unique sengi species by utilizing museum samples from multiple natural history museums covering its whole geographic range. Phylogenetic reconstruction reveals multiple deeply divergent and formerly unknown lineages on a small spatial scale in eastern Africa, highlighting the need for a taxonomic revision. Most surprisingly, we uncovered a distinct lineage restricted to the Udzungwa Mountains. Furthermore, we can show that the assumed allopatric distribution in central Africa represents most likely a sampling artifact. Biogeographic modeling indicates that the African mesic forest system and its dynamics through climate fluctuations shaped the evolutionary and biogeographic history of this taxon. One lineage was able to also occupy much dryer Zambezian woodlands, allowing it to colonize large parts of the continent. Our results suggest multiple morphological, phylogenetic and biogeographic parallels to giant sengis (*Rhynchocyon*), the second but only distantly related lineage of sengis that inhabits mesic forests. Our results thus highlight the crucial role of African forests in sengi diversification.

MARZIPAN POSTER 11

Does behavioral selection correlate with brain size? Testing the evolutionary plasticity of the brain in dogs

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[2] *Naturhistorisches Museum der Burgergemeinde Bern, Bernastrasse 15, 3005 Bern, Switzerland*

[3] *Institut des sciences de l'évolution, Université de Montpellier, CNRS, IRD, EPHE, 2, place Eugène-Bataillon, 34095 Montpellier Cedex 05, France*

Nearly all domestic animals that have been analyzed for brain size change present smaller brains than those of their closest wild relatives. Reduction varies across domesticated taxa, but phylogenetic signals for these differences remain elusive. Dissection studies have indicated that the domesticated brain reduces mosaically, with the limbic system—involved in fear and aggression responses—reducing most compared to other regions. Testing brain size change under domestication has been limited to binary comparisons of wild versus domestic samples. However, a recent study on cattle (*Bos taurus*) found evidence of brain size reduction varying by breed type. Aggressive breeds like bullfighting cattle have larger brains than those of docile dairy cows. Furthermore, brain size reduction appears correlated with the amount and intensity of the human-animal relationship. Here, we test these findings in the dogs, given their morphological and behavioral diversity which has resulted from intensive, controlled breeding. We analyze endocranial volume data for ~2600 pedigree dogs from ~200 breeds with quantifiable behavioral trait data including sociability, openness to strangers, and levels of aggression for these breeds. Our results provide a better understanding of the relationship between brain morphology and behavior. Preliminary analyses support brain size variation according to several behavioral categories.

MARZIPAN POSTER 9

How elastic is the skin of subterranean mammals?

Sabine Begall[1], Delphine del Marmol[2], Stefanie Schülpen[3] & Kai R. Caspar[1,4]

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[2]*Molecular Physiology Research Unit, NARILIS, University of Namur, Namur, 5000 Belgium.*

[3]*Institute for Metal and Lightweight Structures, University of Duisburg-Essen, 45117 Germany.*

[4]*Institute for Cell Biology, Heinrich Heine University, 40225 Düsseldorf*

It has been hypothesized that subterranean mammals have evolved increased skin elasticity to reduce friction when moving through their tunnel systems. This trait is commonly believed to be mediated by greatly elongated hyaluronan polymers in the extracellular matrix of the dermis, which have been reported in two only distantly related burrowing rodents, the West Asian blind mole-rat (*Nannospalax ehrenbergi* - Spalacidae) and the naked mole-rat (*Heterocephalus glaber* - Bathyergidae). Despite efforts to do so, these results have not been replicated and the mechanism by which hyaluronan polymer size could modify skin elasticity remains unclear. In fact, no experimental data on skin biomechanics in burrowing mammals are available. Here, we studied skin biomechanics as well as the molecular mass of dermal hyaluronan polymers in two species of bathyergid mole-rats, the naked mole-rat and Ansell's mole-rat (*Fukomys anselli*), to address these gaps in the literature.

Both species displayed similar hyaluronan profiles with polymers that exceeded average lengths reported for laboratory rodents while being notably shorter (mostly below 2500 kDa) than previous literature reports suggested. However, the skin biomechanics of the two species differ greatly: The skin of the naked mole-rat is remarkably inelastic and stiff when exposed to vertical strains while that of the Ansell's mole-rat is more pliable and similar to that of laboratory rodents. Interestingly, the (dorsal) skin of naked mole-rats tolerates far greater horizontal strains (9.28 ± 2.73 MPa) than that of Ansell's mole-rats (3.91 ± 2.53 MPa). These findings suggest that subterranean rodents do not display increased skin elasticity compared to epigeic forms nor that it is notably affected by hyaluronan polymer size. The unusual biomechanic qualities of naked mole-rat skin probably relate to the unique lack of a pelage in this rodent species.

TALK

A new pygmy sperm whale from Peru broadens the limits of cranial asymmetry

Aldo Benites-Palomino[1], Gabriel Aguirre-Fernández[1], Marcelo R. Sánchez-Villagra[1]

[1]*Department of Paleontology, University of Zurich, Karl-Schmid-Strasse 4, 8006 Zurich, Switzerland*

Nasofacial asymmetry is a significant feature of toothed whales and dolphins (Odontoceti). One of the most extreme cases is seen in the pygmy sperm whales (Kogiidae), as these retain a sole functional naris, and their skulls have been compartmentalized to house their greatly derived nasal organs. A new fossil from Peru evidences one of the most extreme case of asymmetry known so far. The new fossil is characterized by a supracranial basin (region which houses the enlarged nasal organs) occupying most of the right facial region of the animal, a tubular rostrum and a left supraorbital region more anteriorly located than the right one. Particularly, the anterior displacement of the left supraorbital region shows a new pattern unknown for mammals and seen only in a handful of vertebrates.

TALK

Contrasting diversity and disparity patterns in a continental radiation: diversification and morphological evolution in caviomorph rodents

Juan D. Carrillo[1], Daniele Silvestro[1]

[1] Department of Biology, University of Fribourg, and Swiss Institute of Bioinformatics. Chemin du Musée 10, Fribourg, Switzerland.

Understanding the relationship between diversification and morphological variation (disparity) in evolutionary radiations is a major challenge in macroevolution and fossils can shed light on the dynamics of evolutionary radiations. Sister clades share a common ancestor, and could be expected to follow similar evolutionary patterns, but the link between diversity and disparity remains unclear. Caviomorph rodents radiated in the Americas, and the sister clades Octodontoidea and Chinchilloidea diverged early in the radiation. These clades today display drastically different species richness, with 195 living species in the former and six living species in the latter. However, the fossil record documents a high diversity and disparity in Chinchilloidea, including the largest rodent species that have ever lived. We combine data from extant and extinct species to evaluate how the diversification and morphological evolution dynamics shaped their contrasting patterns of diversity and disparity. We infer a total evidence, time-calibrated phylogeny including 149 extant and 52 extinct species, and use craniodental traits and body mass to study their morphological evolution. Our analyses indicate Octodontoidea and Chinchilloidea diverged during the Eocene (ca. 45 Ma). The ancestral body mass was similar for both clades, but subsequently Chinchilloidea shows a higher body mass range through time, reaching its maximum in the Plio-Pleistocene. The rates of morphological evolution in Chinchilloidea were significantly higher than in Octodontoidea. The two clades had similar diversity trajectories until the Miocene, when Octodontoidea shows a trend of increasing diversity until the present, whereas Chinchilloidea diversity stagnates and drops after the Pleistocene. Despite this extinction and a much lower species richness, living Chinchilloidea still occupy a considerable portion of the morphospace in comparison with Octodontoidea. Our findings show a case of remarkable decoupling between species diversity and disparity, highlighting complex relationships between ecomorphological differentiation, species richness, and how they are affected by extinction events.

MARZIPAN POSTER 7

Pleistocene South American native ungulates (Notoungulata and Litopterna) of the Roth collection in Zurich, from the Pampean Region of Argentina

Juan D. Carrillo[1], Hans P. Püschel[2]

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[2]*Red Paleontológica U-Chile, Facultad de Ciencias, Universidad de Chile, Santiago, Chile*

The fossil collections made by early explorers in South America have been fundamental to reveal the past diversity of South American mammals and unravel their evolutionary history. One of the most important early explorers in South America was the Swiss-Argentine palaeontologist Santiago Roth (1850 -1924), who made significant collections of fossil mammals that are housed in museums in Europe and Argentina. The important collections of Roth in Switzerland include iconic Pleistocene megafauna from the Pampean Region (Argentina). The palaeontological significance of the Pampean Region relies on its abundant record of fossil vertebrates that documents diversity dynamics and paleoenvironmental change in southern South America, serving as the basis for the South American chronostratigraphical scale of the late Neogene and Quaternary. The South American native ungulates (SANU) were hoofed placental mammals that radiated in South America. The SANU clades Notoungulata and Litopterna include the last representatives of SANU megafauna in the continent. We revise and describe for the first time the SANU specimens from the Pampean Region of the Roth collection in Zurich. The collection includes two species of notoungulates (*Toxodon platensis* and *Mesotherium cristatum*) and one litoptern species (*Macrauchenia patagonica*). All the species are restricted to the late Pleistocene (Ensenadan land mammal age). Although the SANU diversity in the Roth collection is low in comparison with other groups (e.g., xenarthrans and rodents), some of the specimens are very complete, including skulls and postcranial remains. The completeness of the *M. patagonica* material allows an update and reinterpretation of some of the details of the postcranial skeleton of this iconic species. In addition to its historical importance, the SANU specimens from the Roth collection provide important information to study the paleobiology and evolution of South American megafauna and evaluate hypotheses about their extinction in the continent.

TALK

Funky gibbons: Probing into the dance displays of small apes (*Nomascus* spp.)

Kai R. Caspar[1], Camille Coye[2], Pritty Patel-Grosz[3]

[1] *Institute for Cell Biology, Heinrich Heine University, Düsseldorf, Düsseldorf, Germany*

[2] *Equipe linguae, Institut Jean Nicod, Paris, France*

[3]*Super Linguistics Research Group, University of Oslo, Oslo, Norway*

Crested gibbons (genus *Nomascus*) are known to perform stereotyped sequences of jerking movements, involving the rump and extremities. These social displays are possibly unique among primates and qualify as a form of non-human dance. However, gibbon dances have attracted only little scientific attention so that their structure, meaning, and evolution remain largely obscure.

We analysed close-range video recordings of captive crested gibbons to provide detailed descriptions of dance in four *Nomascus* species (*N. annamensis, N. gabriellae*, *N. leucogenys*, & *N. siki*). In addition, we report results from a survey among relevant professionals, clarifying behavioural contexts of dance in captive and wild crested gibbons. Our results demonstrate that dances in *Nomascus* represent a common and intentional form of visual communication restricted to adult females. While primarily used as a proceptive signal to solicit copulation, dance occurs in a wide range of contexts related to arousal and/or frustration in captivity. Making use of a linguistically-informed view of this complex sequential behaviour, we demonstrate that gibbon dances follow a hierarchically grouped organization – a pattern so far not described for visual displays in other non-human primates.

Crested gibbon dances likely evolved from less elaborate rhythmic proceptive signals such as those found in siamangs and hoolock gibbons. Although dance displays in humans and crested gibbons share a number of key characteristics, they cannot be assumed to be homologous. Despite that, gibbon dances represent a fascinating model behaviour to study the evolution and utilization of complex gestural signals in hominoid primates, including human ancestors.

TALK

Are ageing and longevity linked to sociality in African mole-rats (Bathyergidae)?

P. Dammann[1,2], S. Begall[1], G. Šaffa[3], R. Šumbera[3]

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[2.] *Central Animal Laboratory, Faculty of Medicine, University of Duisburg-Essen, Germany*

[3.] *Faculty of Science, University of Southern Bohemia, České Budějovice, Czech Republic*

Sociality and cooperative breeding are associated with enhanced longevity in insects and birds, but whether this is also true for mammals is still subject to debate. African mole-rats (Bathyergidae) have recently been claimed to be the only mammalian family in which such an association may exist because cooperatively breeding bathyergids seem to be substantially longer lived than solitary bathyergids. However, although ample longevity data are available for several social bathyergids, almost nothing is known about mortality distribution and lifespan in solitary bathyergids. Here we present a comprehensive overview of longevity metrics and annual mortality rates in five African mole-rat species with different social organizations. Our comparative analysis suggests that sociality has indeed a positive effect on longevity in this family. We argue that the exceptional longevity seen particularly in social bathyergids might be caused by a combination of subterranean lifestyle and cooperative breeding.

MARZIPAN POSTER 5

Mammalian cell banking as a backup strategy complementary to species characterization and conservation

Camilla B. Di-Nizo[1], Albia Consul[1], Jonas J. Astrin[1]

[1]*Leibniz Institute for the Analysis of Biodiversity Change, Museum Koenig, Adenauerallee 127, 53113 Bonn, Germany*

Establishing primary cell cultures allows researchers to obtain cells that have conserved most of their original characteristics and functions, which is important for applications in cell biology, cell engineering, and other disciplines. Cells are also an excellent resource to access karyotype information and high-quality DNA, RNA, and other molecules that help to better characterize biodiversity. In addition, viable cells provide long-term preservation of genetic resources, critical to guarantee future conservation programs. Despite their importance, wildlife cell banks are still rare and restricted to only a handful of institutes. Enabled by the FOGS (Forensic Genetics for Species Protection) and BGE (Biodiversity Genomics Europe) projects, our group grows and archives primary cultures of somatic cells from different mammalian species at LIB Biobank. Fresh samples are provided by collaborators and obtained post-mortem or after opportunistic veterinary interventions. Primary cells are produced mostly from skin and eye and propagated cells are routinely frozen in liquid nitrogen for long-term storage. To date, it was possible to cryopreserve cells from 29 mammal species, eight of these vulnerable, five endangered, and one extinct in the wild (*Oryx dammah*). Viable cells from species considered hosts for different pathogens (e.g. rodents and bats) have also stored. Future studies will benefit from accessing the cell bank at LIB Biobank for *omics studies or to induce pluripotent stem cells (relevant e.g. for ex-situ conservation). Our protocol can be followed as a standard method for establishing primary cells in further projects striving to leave a meaningful physical legacy to the research community, lending itself for future applications we may not even be aware of today. Furthermore, we as a Biobank facility guarantee the infrastructure to process and store mammalian cells and encourages the deposition of fresh samples in order to increase the diversity of our bank and aid the research community.

MARZIPAN POSTER 4

A new karyotype of *Neacomys rosalindae* (Rodentia, Sigmodontinae) and the importance of cell culture for biodiversity knowledge

Camilla B. Di-Nizo[1], Jorge Brito[2], Ricarda Wistuba[1], Albia Consul[1], Jonas J. Astrin[1]

[1] Leibniz Institute for the Analysis of Biodiversity Change, Museum Koenig, Adenauerallee 127, 53113 Bonn, Germany

[2] Instituto Nacional de Biodiversidad (INABIO), Pasaje Rumipamba 341 y Av. de los Shyris, PB 17-07-8976, Quito, Ecuador.

Spiny mice of the genus *Neacomys* are small-bodied oryzomines distributed from easternmost Panama to northern Bolivia that have recently been subject to a number of new species descriptions. In fact, nine new species were described from 2018 until today. However, only five of these new species had their karyotype described. *Neacomys rosalindae* is a recently-described species from northeastern Peru, distinguished from congeneric species by morphology and karyotype (2n=48, FN=50). In this work, we describe a new karyotype for a male of *N. rosalindae* collected in Napo, Grand Selva, Ecuador. Chromosome preparation was obtained in vitro from cells established from retinal explant sampled in the field. The karyotype shows 2n=48, FN=61 and is composed of a large heteromorphic pair, one acrocentric and one submetacentric, seven small biarmed pairs and 15 medium to small acrocentric pairs. C-banding showed heterochromatic signs at the pericentromeric region of autosomes and at Xp and Yq. The heteromorphism observed in this work is possibly due to pericentric inversions and is being described herein for the first time. Pericentric inversions lead to reduction in gene flow and to the accumulation of incompatibilities that may fuel the process of speciation. This work corroborates that *Neacomys* presents a hidden diversity that can only be revealed through integrative studies including morphology, molecular phylogeny and cytogenetics. In fact, *Neacomys* show a range of diploid number from 28 to 64, and fundamental number from 36 to 70, which makes cytogenetics important for species recognition, since each species possess species-specific karyotypes. Furthermore, we show that it is possible to establish cell cultures from samples collected in the field and emphasizes the importance of establishing cells from Sigmodontinae rodents and other mammalian lineages for a better understanding of biodiversity, obtaining high quality metaphases and for future conservation projects.

TALK

Seasonality and mammalian intestinal length: where life history meets anatomy

María J. Duque-Correa[1], Carlo Meloro[2] and Marcus Clauss[1]

[1]*Clinic for Zoo Animals, Exotic Pets and Wildlife, Vetsuisse Faculty, University of Zurich, Winterthurerstr. 260, 8057 Zurich, Switzerland*

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There are several proposed drivers of intestinal length among vertebrates. Mainly diet is advocated. Reduced dietary digestibility, as is the case in herbivore diets, has been related to longer intestinal tracts. More recently, ecological factors have been related to mammalian intestinal length. Elongation of the large intestine has been found in species that inhabit arid ecosystems. Shorter intestinal lengths are characteristic of flying, and longer small intestines of marine mammals. These findings suggest that intestinal length is shaped not only by dietary, but also, by ecological parameters. Here, we propose that the seasonality of the natural habitat could be an important driver, and use a group of mammals with cutaneous spiny appendages as a case in point.

Three species occupying similar dietary niches, the Greater hedgehog tenrec (*Setifer setosus*), the African hedgehog (*Atelerix albiventris*), and the European hedgehog (*Erinaceus europaeus*), have a very similar intestinal morphology (as would be expected in insectivores), yet striking differences in intestinal length (species listed in order from shorter to longer intestinal length). However, none of the above-mentioned factors, including diet, account for this variation. We propose that indicators of seasonal life history (either taken from the habitat, such as the latitude of the natural habitat of a species, or pace-of-life indicators such as gestation length and hibernation) can further predict intestinal length. Combining data on mammalian intestinal length with pace-of-life variables, we expect to assess the extent to which intestinal length is driven by such variables. For example, there is a positive association across mammals between latitude of the natural habitat and small intestine length, and a negative association between gestation length and small intestine length, suggesting that the bursts of demand in the active period of seasonal mammals are paralleled by adaptations of the digestive tract.

TALK

Evolutionary patterns in cranial growth in sigmodontines (Rodentia, Cricetidae)

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Sigmodontines comprise one of the most diverse radiations in neotropical mammals. Although cranial ontogeny has been studied in various mammals, it remains poorly studied in this group. In this report, we quantified the ontogenetic pattern for 22 sigmodontine species (Abrotrichini, Akodontini, Andinomyini, Oryzomyini, and Phyllotini tribes) and 8 outgroups (Cricetinae, Murinae, Gerbillinae, Spalacinae, Glirinae, and Thryonomyidae), generating partial reconstructions of ancestral allometric growth patterns, and evaluating the role of evolutionary history in the cranial ontogeny of the group. Sigmodontines are conservative in growth patterns, without a single pattern defining tribes. The allometric growth of the skull has mostly a negative trend, with Akodontini being the most isometric tribe and Phyllotini the most allometric one. The allometry of the variables associated with the neurocranium was mostly negative, while those linked to trophic functions showed some positive allometry or isometry. A general cranial elongation was detected, with variables associated with skull width or height showing lower rates, while elongation was a generalized pattern and likely a plesiomorphic condition. The growth and development of the skull were associated with changes in the musculature functionally involved in biting and chewing. Most of the changes occurred in early postnatal stages, achieving an early morphological optimum. Few changes in the growth rate were detected in the internal nodes, and stasis throughout the evolution was recurrent. The few synapomorphies that define the ancestry of Sigmodontinae conform a pattern with little laterally expanded zygomatic arches and globose braincases. The conserved pattern can be attributed to the biomechanically optimal morphology for processing omnivorous diets, suggesting that the generalized morphology allows the exploitation of multiple food types with little morphological adjustments.

MARZIPAN POSTER 12

Insights on the paleoneurology of *Sipalocyon* (Metatheria, Sparassodonta), an extinct predator from the Early Miocene of Patagonia, Argentina

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In this contribution we study through µCT-scanning and digital reconstructions the paleoneurology of an extinct Early Miocene predator, marsupial relative, based on three specimens that represent two species: *Sipalocyon externus* (MACN-CH 1911, almost complete cranium from the Sarmiento Formation; Colhuehuapian Age) and *Sipalocyon gracilis* (AMNH VP-9254, complete cranium and MACN-A 5952, petrosal from the Santa Cruz Formation; Santacrucian Age). The aim of the study is to investigate structures of the internal anatomy and infer paleoecological aspects of *Sipalocyon*. General anatomy of the encephalic cavity in both species is similar to extant didelphids. Encephalization quotients are alike the values of metatherians (~0.3). The circulatory system is characterized by an accessory diploic transverse sinus running dorsally and parallel to the true transverse sinus, likely hematopoietic in function. Nasal elements (e.g., turbinals, ossified nasal septum, cribriform plate) of *S. externus* exhibits typical marsupial anatomy. Sense of olfaction is estimated akin to the one of the domestic cat on the basis of the study of the cribriform plate and the cast of the olfactory bulbs. Reconstruction of the tympanic membrane from the preserved ectotympanic of *S. externus* indicates hearing frequency similar to the one estimated for *S. gracilis* based on its stapes. Those frequencies are within the ranges of values registered for extant carnivorous marsupials (Dasyuromorphia). Orbital orientation of *Sipalocyon* is typical of hathliacynids and extant carnivorous mammals, exhibiting high values of orbital convergence for stereopsis. This study reconstructs *Sipalocyon* as the typical small-bodied (2–5kg) hypercarnivorous metatherian with sensory capabilities (olfaction, hearing, and vision) that enable similar hunting to extant felids.

TALK

Controversies concerning cervid systematics, antler tine homologies and the special case of *Elaphurus davidianus*

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Antlers as the diagnostic character of cervids have been used in the past to establish a classification of their fossil and living representatives. With increasing re-appreciation of morphological characters in recent years, they are now more frequently used in addition to molecular data for phylogenetic reconstructions. Using antler traits requires finding a consensus on the homology of structures, which can be challenging.

After reviewing, comparing, and critically evaluating past and recent attempts to homologise antler structures and contrasting opinions, we provide a basis for further scientific exchange on the topic. We present developmental aspects of antler branching patterns and discuss the potential of homologous antler traits for reconstructing cervid systematics.

Another critical aspect of establishing systematic relationships in cervids is the use of heterogeneous datasets, e.g., nuclear vs. mitochondrial markers, resulting in partly conflicting hypotheses on the systematic position of certain species. Particularly, the placement of *Rucervus eldii* and *Elaphurus davidianus* is affected by using different molecular markers. We address current discussions on this topic and elaborate whether antler morphology and molecular data can provide a consistent picture on the evolutionary history of cervids. In this context, special attention is given to the antler morphology of the enigmatic Pere David's deer.

TALK

Insights into the evolutionary history of the extinct blue antelope

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The blue antelope (*Hippotragus leucophaeus*) was an iconic species of South Africa and was endemic to the Cape Region of southern Africa. It is the only large African mammal species that went extinct in historical times (c. 1800 AD). Its evolutionary history is not well known due to its early extinction and as only few historical specimens exist in museum collections today. Several reasons for its extinction have been discussed, with humans likely playing a decisive role.

Here, we sequenced a mounted museum specimen to a mean genome-wide coverage of ~43.6x and performed phylogenomic, demographic, and genetic diversity analyses to better understand the evolutionary history and eventual extinction of the species.

Preliminary results show that the effective population size of the blue antelope decreased continuously. In addition, we had a deeper look at gene flow between the blue antelope and its congeners the roan (*H. equinus*) and the sable antelope (*H. niger*) and when it might have happened. Here, preliminary results indicate that past gene flow occurred from the roan into the blue antelope. We also analysed the inbreeding status of the population the museum specimen originated from and its heterozygosity.

Our study presents new information about the evolutionary history of the blue antelope. We hope our findings will provide valuable new knowledge to help prevent comparable fates for species that are similarly threatened today.

TALK

Ontogeny and growth of the locomotor muscles in primates: impact of developmental strategy

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Newborn and young animals are often at a competitive disadvantage compared to adults due their smaller absolute size. It has been proposed that selection may favour the development of muscles during ontogeny such that young animals have disproportionately strong muscles compared to adults allowing to survive. However, in species with prolonged parental care this may not be the case. Here we explored the growth of the hind limb muscles and their functional properties in three species of primates (*Microcebus murinus*, *Papio anubis* and *Papio papio*), two of which exhibit extensive parental care (*Papio anubis* and *Papio papio*). Data on hind limb muscle mass, muscle fibre length, and muscle cross-sectional area (PCSA) were obtained by dissecting the hind limbs of over 60 individuals. Accelerated development of muscle mass and strength was common for juvenile *Microcebus murinus* and observed for finger flexors and extensors in juvenile *Papio anubis.* For most muscle groups including the knee extensors, hip flexors, and supinators, development was accelerated in adult *Papio anubis* and adult *Papio papio*. These data suggest that prolonged parental care may relax selection on juvenile locomotor performance compared to species with more precocial developmental strategies such as *Microcebus murinus* where the young forage independently soon after birth and for which stable locomotion in an arboreal environment is crucial.

TALK

Diversity of small mammals in the International Park Lower Oder Valley

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We present first insights and results of our project 'Diversity and ecosystem function of small mammals in the Lower Oder Valley - an international project'. From 2021 to 2026 a German-Polish team of small mammal researchers is investigating the terrestrial small mammal communities in the Lower Oder Valley National Park (Germany) and the Lower Oder Valley Landscape Park (Poland). Small mammals are captured with three types of live traps in a variety of habitat types and species diversity, abundances, and habitat preferences are determined. A comparison with comprehensive studies of the small mammal fauna in this area from 1992 (SCHRÖPFER & STUBBE 1996) and 1995 (MÄDLOW & SCHIWIETZ 1998) will allow conclusions on changes in 30 years.

In 2021-2022, eight areas in the northern part of the Oder Valley were sampled in three trapping campaigns, including meadow and forest habitats. With 537 captures in 1584 trap nights, 292 individuals from 11 small mammal species (4 shrew species and 7 rodent species) were recorded. The most frequently captured species so far are the striped field mouse (*Apodemus agrarius*), yellow-necked mouse (*Apodemus flavicollis*), bank vole (*Clethrionomys glareolus*) and common shrew (*Sorex araneus*). The water shrew (*Neomys fodiens*), lesser white-toothed shrew (*Crocidura suaveolens*) and northern vole (*Microtus oeconomys*) were the least common captures.

The main goals of our project are to provide a better understanding of the current distribution and ecology of small mammals the Lower Oder Valley, potential changes in the diversity and abundance due to 30 years of protection in the NP, but also due to climate change and invasive neozoons like the raccoon (*Procyon lotor*). The updated knowledge can then contribute to more effective management of small mammal populations and other organisms that depend on them.

MARZIPAN POSTER 3

Insights into cranial development and ossification patterns in the tayra (*Eira barbara*): A comparative analysis of varying developmental stages

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This study investigated the cranial development of *Eira barbara* and tested two different segmentation modes to obtain 3D models of the skulls. Skulls of three different developmental stages were selected, including two foetuses, one juvenile, and one adult. CT scanning was conducted and the cranial bones were segmented using the Amira software. A classic semi-automatic segmentation and a new hierarchical watershed segmentation tool were applied. The biological examination focused on changes in overall skull anatomy, ossification patterns, and suture closure timing. Prominent changes between younger and adult specimens included advanced lateral flaring of zygomatic arches, development of the nuchal crest, and elongation of the braincase. Notably, the gaps between neurocranial bones, especially within occipital bones, were larger in foetuses compared to viscerocranial bones and braincase components. This indicates a sequential process of ossification and fusion, with viscerocranial bones and the skullcap undergoing complete ossification before neurocranial bones. Occipital bone sutures closed earliest, consistent with other mammal species, whereas viscerocranial sutures remained open in the adult specimen, as seen in other mammalian species. The absence of coronal and sagittal sutures in the adult skull suggests completion of brain growth and stabilization of the braincase during maturation. The hierarchical watershed segmentation was especially useful and time-saving in the early developmental stages due to the open sutures and became less efficient with an increasing fusion compared to the classic approach. In summary, this study provides valuable insights into cranial development, ossification patterns, and suture closure timing in *Eira barbara* and highlights the developmental differences between viscerocranial and neurocranial bones and their respective sequences.

TALK

The shape and allometry of the brain and inner ear of the Steller's sea cow

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Sirenians (dugongs, manatees, and their extinct relatives) are obligate aquatic mammals with a rich fossil record extending back 56 million years. They are unique among aquatic mammals because of their strict herbivory and their smooth and small brains. Within sirenians, one stands apart by its gigantic size: the recently-extinct Steller's sea cow (*Hydrodamalis gigas*). These orca-sized sirenians were peculiar not only because of their sheer size; their habitat, diet, and social structure were also different. We hypothesise that the traits above had effects on the shape and size of the brain and inner ear of *H. gigas*. To test this, we analysed the morphological variation of brain and inner ear endocasts of the Steller's sea cow and a comparative sample of sirenians. We produced 43 three-dimensional models rendered from computer-tomography scans for eight extant and extinct sirenian species. The shape of the brain and inner ear mostly reflected phylogenetic relationships, as more closely-related species were more similar. The bulbous brain shape of *H. gigas* was found to be remarkably different from the elongated brains of its closest relatives (dugongids). In contrast, the shape of the inner ear of *H. gigas* mostly resembled its relatives in morphology, with a deviation only in the lateral canal. In terms of allometry, there is a linear relationship between body size and the shape of brain and inner ear. We suggest that brain dimensions are reflecting the shape of the skull, which is strongly influenced by feeding type and that variations in inner ear shape reflect habitat.

TALK

The mammalian knight: when evolution leads to armor and weaponry

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Glyptodonts are the only mammals that have evolved heavy armor and tail weaponry. While armor is an ancestral clade feature, tail weaponization followed a more complex evolutionary history. From an unarmed highly-armored tail to a spiked tail club, glyptodonts display a wide variety of tail anatomy, whose function remains highly debated. These herbivorous giants used these adaptations to defend themselves, however, the evolution of tail weaponry remains questioned between: (1) increasing protections against predators, notably due to synchronous acquisitions towards stronger armor/weaponry with the Great American Interchange; (2) intensified increase in intraspecific fighting. To preliminary investigate these two scenarios, we examined the anatomy of the four tail morphotypes of Pleistocene glyptodonts from the Santiago Roth Collection at Zurich in relation to body armor and size variation, using eight morphological traits. This approach enabled us to construct a spectrum from the most passive defense (*Glyptodon*), to the most active defense (*Doedicurus*). While in the first extreme, the anatomy of the tail functioned primarily to reinforce the armor, in the second, the weaponized tail anatomy alone does not allow to favor either hypothesis. We have therefore started to explore tail biomechanics in *Doedicurus*, using a combination of modeling and robotic approaches. Preliminary investigations suggest a coordination of tail and body movements lead to notably higher impacts than tail movements alone. Given the velocity of Pleistocene predators, the slow lifestyle of glyptodonts, and the potentially complex tail motion, we favor the hypothesis of an evolution toward tail weaponization for intraspecific fighting (2), although we cannot exclude its use against predators (1). The armor and weaponry are therefore probably the combined witnesses of a strong natural and sexual selection that brought glyptodonts to the pinnacle of mammalian protection until the late Pleistocene drastic climatic changes and their interaction with humans brought their history to the end.

TALK

Behavioral and histological investigations of the magnetic sense in subterranean mole-rats

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The ability to sense the Earth's magnetic field and use it for orientation and navigation is widespread in the animal kingdom. The cellular and neuronal mechanisms of magnetic orientation are, however, still poorly understood. Mole-rats are subterranean mammals from Africa with a long history in magnetoreception research as their magnetic sense was discovered more than 30 years ago. Much of our knowledge is obtained from the Ansell's mole-rat, *Fukomys anselli*, which build nests in the magnetic South-East region of an open field arena. The nest-building assay, due to its reliability, has become the standard paradigm to study magnetoreception in rodents. However, this assay has a major limitation - it is time consuming. This makes data collection inefficient and renders it unusable in the study of acute behaviours. We therefore went on a hunt for a fast, simple and replicable behavioural assay to demonstrate the perception of magnetic fields. We hypothesised that mole-rats primarily use their magnetic sense during exploration, e.g. when tunneling. Here, we present two explorative paradigms, the novel magnetic object and maze navigation. To maximize the level of experimental control, we used automated closed-loops between live animal tracking and a magnetic coil system to create a "virtual magnetic environment" that responds to the position of the animal. This enables us to test multiple behavioural paradigms within the same coil setup, under controlled conditions. We will present the latest results of this behavioral interrogation of the mole-rat magnetic sense alongside our multimodal histological efforts to identify the magnetoreceptor cells.

MARZIPAN POSTER 8

Combined effect of Insular dwarfism and domestication in horses of Greece and Japan

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The horse varieties from Skyros and Rhodes islands are extremely small, reaching shoulder heights of only about one meter. Furthermore, the Japanese archipelago is home to eight small, native horse breeds. We aim at investigating the evolutionary morphology and provide a comprehensive review of historical documentations on these horses of great cultural significance in Greece and Japan. Cranial data from historical literature is integrated with data on newly gathered skulls to create and analyse a measurement dataset featuring various domestic and wild horse breeds and varieties. We use non-invasive imaging to study and measure 3D models of the bony labyrinth, housing the inner ear, and the braincase endocast. When considering the effects of allometry, we show that size explains a large amount of the shape variance in the cranium, the inner ear, and the brain. Changes in morphology result from an interplay of domestication and island-living, which both affect body size.

TALK

What can the appendicular anatomy of African mole-rats (Bathyergidae) tell us about their evolution?

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The present contribution summarizes the results of a series of studies elucidating the morphological adaptations of the appendicular system of the iconic African mole-rats (Bathyergidae). African mole-rats are highly specialized subterranean rodents from sub-Saharan Africa exhibiting unique physiological and ecological characteristics among mammals, such as an extended longevity (up to 30 years), low metabolic rates, development of distinct digging strategies (chisel- vs. scratch-digging) and formation of highly cooperative breeding systems (up to 300 individuals). Nevertheless, their postcranial anatomy has been largely overlooked in comparison to their craniodental adaptations. A better knowledge of their phenotype and development are crucial to fully understand the evolution of such remarkable adaptations. We implemented multiple approaches (e.g. functional anatomy and bone microstructure) to unravel how these small mammals have specialized to fossorial life. More than 1100 bones from >500 individuals (10 rodent species), including humerus, ulna, femur and tibia allowed the determination of patterns of disparity, development and ontogeny of fossorial characters, as well as patterns of intraspecific variation, bone histodiversity, and the effects of reproduction on their skeleton. In functional terms, although most bathyergids exhibit highly specialized limb bones, chisel-tooth diggers often show enhanced skeletal specialization than scratch-diggers, suggesting a more important role of limbs for head-burrowing, and a reconsideration of the typical form-function approaches. New data on the distinct phenotype of naked mole-rats, along with the recent paleontological findings in the group, allowed a preliminary depiction of the evolutionary history of this family. Our findings represent a significant advancement on the skeletal biology of subterranean mammals, and along with other studies on their biology and ecology, these efforts are essential to comprehend the factors involved in their successful evolution in the African continent.

MARZIPAN POSTER 13

Does the forelimb musculoskeletal system differ between mole-rats with different digging modes?

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Morphological convergence among fossorial mammals is suggested to be the result of similar functional demands associated with the digging and construction of burrow systems. Among Bathyergidae, chisel-tooth diggers use their highly procumbent incisors for breaking-up soils, and have a markedly divergent cranial anatomy to enhance morphological specializations of their skull and incisors as compared to scratch-diggers, which use their long foreclaws for breaking-up soils. Whether the appendicular digging apparatus of mole-rats follow a similar functional trend it is debatable. We assessed the scapular morphology and the forelimb musculature of all four solitary bathyergids: two chisel-tooth diggers, *Heliophobius argenteocinereus* and *Georychus capensis*; and two scratch-diggers, *Bathyergus suillus* and *Bathyergus janetta*. In general, all bathyergids showed a similar set of muscles, except *H. argenteocinereus* which lacked *m. epitrochlearis* (responsible of humeral retraction and elbow extension), and *H. argenteocinereus* and *G. capensis* which lacked *m. coracobrachialis* (responsible for flexion and adduction of the glenohumeral joint). Remarkable differences between digging groups were associated with relatively larger scapulae, wider olecranon processes and relatively larger muscles in *Bathyergus* in comparison to *H. argenteocinereus* and *G. capensis*. A larger scapula allows increased attachment areas for the origin of *m. supraspinatus*, *m. infraspinatus* and *m. subscapularis*, which have a direct impact on increased extension and flexion of the humerus, adduction of the scapula, and overall stabilization of the scapular girdle, all contributing features to maximize elbow extension. Moreover, several muscles in *Bathyergus* were tightly associated (often fused), evidencing clear adaptations to increase muscle size and strength. Our results suggest that most functional requirements needed for scratch-digging behavior are concentrated in the shoulder and elbow, which are fundamental pivots for generating greater out-forces. This study will allow us better understand the evolutionary changes associated with the emergence of fossoriality in Bathyergidae.

MARZIPAN POSTER 6

Development of multiplex SNPSTR marker sets for illegally traded animals

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Overexploitation is one of the main drivers of the biodiversity loss we are experiencing today. One aspect of overexploitation is the illegal trade in wildlife, which is estimated to be worth USD 7-23 billion annually. Authorities often lack reliable molecular tools to detect and prove illegal wildlife trade. Issues range from population origin, parentage/kinship testing to individual identification. To better detect and combat wildlife crime, the BMBF-funded FOGS (Forensic Genetics for Species Protection) project is establishing novel marker sets for species illegally traded in Europe. For this purpose, we have selected SNPSTR markers. They combine microsatellites with SNPs in the flanking region to increase their discriminatory power. We present a pipeline for the highly efficient development of SNPSTR markers: To generate a new SNPSTR set, the genome is first screened for suitable STRs. A multiplex reaction is then designed and performed for 10 animals per species. After sequencing, the samples are analysed for variation and 20 markers with a variable STR and SNPs in the flanking regions are selected. To date, we have successfully developed the first SNPSTR sets for mammals (e.g. *Cebuella pygmea*) and are continuing to develop more sets for other species, potentially applicable to more or less closely related taxa as well. FOGS will make the marker sets freely available to authorities and researchers via a web portal (https://fogs-portal.de/en/ - currently under construction). The database will provide access to all the information needed to use the SNPSTR sets without the need for time-consuming and costly marker design and validation. Such a SNPSTR database for wildlife forensics will be the first of its kind. In this way, FOGS will help to safeguard protected wildlife from overexploitation - and species from extinction.

TALK

Exploring drivers of external eye appearance in macaques

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Primates have some of the most colorful skin, fur and eyes among mammals. Macaques are, after humans, the best studied group of primates. They are also geographically widespread and boast diverse external eye morphology. This makes them an interesting genus to test hypotheses regarding the diversity in external eye appearance in primates. In this study, we find no support for communicative functions of external eye appearance in macaques. We find that macaques in areas with greater UV radiation have more pigmented skin, like humans, but we find no relationship between pigmentation in the eye and UV. However, detailed comparison of pigmentation patterns within individuals strongly suggests photoprotective functions. We also did not find any relationship between latitude and iris hue. Lastly, we report species-specific differences in external eye appearance between the sexes, and throughout development. Sex differences are small, so we believe them to be of little functional significance. Similar developmental differences have been found in other primate taxa, suggesting shared developmental constraints.

MARZIPAN POSTER 14

Age-specific effects of density and weather on body condition and birth rates in the Przewalski's horse

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Reproduction in young females can respond particularly sensitively to adverse environmental conditions, although empirical support from individual-based long-term studies is scarce. Our study was based on a 20-year data set from a Przewalski's horse population (*Equus ferus przewalskii*) living in the Pentezug reserve of the Hortobágy National Park in Hungary. We investigated the effects of large-herbivore density (horses and cattle) and of weather conditions experienced during different life stages on females' annual birth rates. Foaling probability was very low in 2-year-olds, reaching maximum values in 5- to 10-year-olds, followed by a decrease in older females, indicating reproductive senescence. Young and old mothers (as opposed to middle-aged ones), which had previously nursed a foal for at least 60 days, reproduced with a lower probability. Foaling probability and body condition of young females was lower when large-herbivore density was high. Reproduction was also influenced by interactive weather effects during different life stages. Low late-summer precipitation during the females' year of birth was associated with a pronounced decrease in foaling probability in response to harsh late-winter temperatures prior to the mating season. In turn, increased amounts of late-summer rain during this early age in combination with more late-summer rain during the females' current pregnancy led to an increased reproductive probability in 2- to 3-year-olds. These results were in line with the ameliorating effects of late-summer rain on body condition during early life, as well as with negative body condition effects of low winter temperatures. In conclusion, our findings highlight early-life effects of late-summer rain in combination with density and weather during potential pregnancy on foaling probability, in particular in young females.

TALK

Bone microstructure and histology: unraveling the evolutionary history of the antler cycle

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The unique regenerative nature of antlers, being branched and deciduous apophyseal appendages of frontal bones of cervids, is the only example of complete organ regeneration in mammals and one of the most remarkable phenomena in vertebrates. The physiology behind is complex and synchronized with behavioral and environmental specifics. It was interpreted as an evolutionarily successive achievement of cyclic necrosis, abscission, and regeneration in cervids and the evolutionary origin was associated with permanent precursors. However, novel insight into growth modes of evolutionary early antlers surprisingly provides evidence against that hypothesis. Microstructural and histological studies of antlers of ten early cervid species, including the oldest known, dating from the early and middle Miocene (approx. 18 to 12 million years old) of Europe show that growth patterns and a regular cycle of necrosis, abscission and regeneration are consistent with data from modern antlers. The results indicate that primary processes and mechanisms of the modern antler cycle were not gradually acquired in multiple steps during evolution, but were fundamental from the earliest record of antler evolution. Hence, explanations why deer shed antlers have to be searched in basic histogenetic mechanisms. Accordingly, cervids always have had to cope with the periodic loss and regain of their cranial appendages, and their evolutionary history was constantly accompanied by the competition between physiological costs and socio-reproductive success. The previous interpretation that proximal circular protuberances, burrs, are the categorical traits for ephemerality is refuted.

TALK

Unravelling the adaptive landscape of limb morphology in mammals: the role of locomotor modes

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The metaphor of the phenotypic adaptive landscape has contributed to our understanding of the macroevolutionary patterns underlying morphological diversity. The outstanding phenotypic variation of mammals has been suggested to be impacted by a series of selective regimes, notably for the direct links between limb morphology and the environment where locomotion takes place. However, these associations have been rather addressed across a somewhat limited taxonomic diversity. We tested whether locomotor mode defines phenotypic variation of over 800 mammal species, using the adaptive landscape model while covering the family-level diversity of Mammalia. We show that the diversity of body mass and, most remarkably, forelimb morphology is best explained by a multi-peak structure of adaptive zones driven by locomotor mode. Terrestrial locomotor modes exhibit nearby optima rendering transitions between locomotor modes simpler. Highly specialized locomotion in fluids or dense media, including flight, aquatic, and fossorial locomotion, drives the most extreme morphologies associated with the most isolated adaptive optima, indicating that shifts towards these specializations are possibly irreversible and extremely rare. The degree of locomotor specialization did not present a clear association with the rates of morphological evolution, with different functional constraints likely driving different evolutionary dynamics. These findings contribute to our understanding of how mammalian morphology adapted in diverse environments and highlight the significance of adaptive landscapes in elucidating selective regimes driving phenotypic diversity.

TALK

Reproductive performance in the European hare (*Lepus europaeus*): are maternal body conditions decisive?

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In female mammals, reproduction, and in particular lactation, is the energetically most crucial life-history phase. Reproduction is strongly controlled by body reserves and food availability, thus females with better body condition or food supply are alleged to have higher reproductive output. In addition, the growth and mortality of young mammals depends on their postnatal development. Consequently, the degree of precociality affects energetic demands for both mothers and young. To study the reproductive performance of the precocial European hare (*Lepus europaeus*), we analysed relationships between six predictor variables describing maternal and environmental effects and nine response variables relating to reproduction from 217 captive females. We compared the data with those of precocial and altricial mammal species from a broad literature search. For hares, we found: (1) Heavier females had heavier litters at birth. (2) In summer and spring, total litter mass was larger than in winter. (3) At the end of lactation, the litters of multiparous females were heavier than those of primiparous females. (4) Both older females and females giving birth for the first time had relatively high leveret mortality during lactation. Evaluating our results with the literature for other mammals disclosed that the body condition (i.e., body mass) of females before birth is predictive of reproductive parameters in both precocial and altricial species. In the precocial hare, female body condition is no longer predictive of reproductive parameters at the end of lactation, whereas in altricial species, female body condition remains predictive of reproduction until the end of lactation. We assume that these effects are caused by precocial offspring feeding on solid food soon after birth and, therefore, being less dependent on the mother's body condition during lactation than altricial offspring. In accordance with this, precociality may have evolved as a way of buffering offspring against maternal effects.

MARZIPAN POSTER 1

Positive effects of set-asides on spring density, increment of growth, hunting bag and number of subadults in European hare (*Lepus europaeus*) populations

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Farmland biodiversity in Europe has declined since agricultural intensification began in the early 1900s. Non-farmed features are of great importance for the promotion of plant and animal species including the European hare (*Lepus europaeus*). A reduction in reproductive success has been proposed as an immediate cause of the decline in European hare abundances. Female fertility is not reduced and leveret survival is inherently low in this lagomorph species. However, hunting bags imply that leveret mortality has increased in recent decades. We studied the effect of set-asides on population trends of hunted European hares by analysing data of spotlight counts and of hunting bags in arable landscapes in Lower Austria during six years. We found no interannual and interareal differences in reproductive output of adult females. Consequently, female reproductive output had no effect on population growth of the hares. Leveret mortality rate was lower in the study sites with a high proportion of set-asides (9 and 13%) than in the sites with a lower proportion of set-asides (3 and 5%). We recorded a positive effect of leveret survival rate on population growth and next year's spring density. Furthermore, the proportion of set-asides positively affected spring density, population growth, hunting bag, leveret survival rate and number of subadults in autumn. Hence, set-asides promote the survival of leverets and, equally, population growth and spring density. Therefore, set-asides are a very important habitat measure and an evidence-based conservation tool for the promotion of this species in arable landscapes.

MARZIPAN POSTER 10

Analysis of reproductive performance in brown bears by staining placental scars

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The Swedish brown bear *Ursus arctos* population is protected, but managed with legally defined hunting seasons. Management decisions (e.g., hunting quotas) are frequently changed and should be based on knowledge about demographic parameters, but collecting sufficient data in the field is time consuming and expensive. An efficient method to collect data on reproductive output could be counting placental scars in the uteri of female brown bears, because hunters in Sweden are obligated to collect samples (including reproductive organs) of harvested bears. We assessed the reliability of placental scar counts to determine reproductive performance by counting the number of young radiocollared brown bears with females and comparing that with placental scar counts after those females were harvested. We found that staining uteri improved the detection of placental scars. Detectability of placental scars, described by the difference between number of scars detected before and after staining the uteri, increased significantly with female age. Small deviations between number of placental scars and number of observed cubs-of-the-year accompanying females might have occurred because of postpartum cub mortality prior to leaving the den. Placental scar counts can provide accurate information on age of primiparity, evidence for reproductive aging (senescence), and reproductive productivity and therefore inform decisions regarding adaptive management, sustainable hunting, and conservation.

TALK

A comprehensive overview of wear analysis in life history evolution

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In mammals, mechanical wear analyses have been widely applied to infer diet, use, habitat and climatic conditions, on individual, species and population level. During the last 15 years, combined studies of wear analyses on different scales, and based on museum material, in-vivo, in-vitro, and actualitstic experiments as well as simulations have shed new light on the importance of abrasives in the wear process. Yet, new questions are raised regarding how varieties of factors, for example structure, physical and mechanical properties of the diet, affect the wear process. Here, we present a synthesis on the recent advances to characterize the old as well as new important key players of the wear process that are linked to approaches in biomechanical engineering, functional morphology and digestive physiology.

Further, the most common pitfalls, new tools, and solutions are presented that can help initial and advanced end users in various scientific disciplines. In addition, we highlight that there is still a need for standardization of experimental and analytical procedures, to increase repeatability and reproducibility and thus guarantee high data quality and foster future exchange of data. We suggest that there is still more potential to utilize wear analyses for in diverse research scenarios, including both mammalian and non-mammalian vertebrate taxa and even in invertebrates, extant and extinct species, but also for surfaces not related to feeding. Our synthesis should be a first step towards a better understanding of the biomechanics of wear as well as the scaling of the complex and multi-factor interactions of wear surfaces.

TALK

Evolution of cranial ontogeny in felids (Carnivora: Felidae)

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The family Felidae forms a monophyletic clade supported by molecular and morphological data and is organized into eight major lineages that radiated rapidly during the mid-late Miocene. All felids are efficient predators and share morphological characters related to a diet exclusively based on flesh (hyper carnivory), such as reduced non-carnassial postcanine dentition and short faces. In this report, we analyzed the ontogenetic pattern in a sample of 1296 skulls of 16 species of felids belonging to five of the eight extant lineages by applying 3D geometric morphometric and linear techniques. The study aimed to explore the variation in cranial size and shape as well as the evolutionary patterns of such variation. Our results indicate that the species diverged in morphospace into two groups resembling ecomorphs previously reported: small and large cats. In this way, the evolution of ontogenetic changes in the lineages seems to be more influenced by size. The most important ontogenetic changes observed in the skull were the development of cranial structures related to the increase of placement of attachment of masticatory and neck musculature, which are essential during the killing bite and slicing of flesh. These modifications are directly linked to emphasizing predatory skills and coincident with the change from a milk to a carnivorous diet. The patterns of change observed in adults suggest that the skull is not morphologically conservative, and the ontogenetic scaling of most cranial dimensions does not approach to isometry in felids. These results do not agree with those previously reported for this group.

TALK

Impact of local and landscape scale effects on the occurrence of the common hamster (*Cricetus cricetus*) in a structurally simple agricultural landscape

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Agricultural intensification is one of the main drivers for biodiversity loss in agricultural landscapes. The reasons for the species decline are scale-dependent. At the landscape scale, factors such as habitat loss or the expanding of agriculturally used land, and at the local scale, increases in pesticide use or intensified soil tillage negatively affect species richness. One of the species severely affected by the intensification and threatened by extinction is the common hamster (*Cricetus cricetus*). Effects on the hamster's occurrence in complex landscapes have already been investigated, but simple agricultural landscapes, such as those found in Saxony-Anhalt, have rarely been studied so far. In this project we investigated parameters on a local (vegetation cover and density, field size, field vole infestation, soil moisture, predator density) and landscape level (landscape composition and configuration) that could impact the occurrence of the hamster. For this purpose, our research took place in four areas. First results from the autumn survey in 2022 showed that local scale hamster protection measures (e.g. delayed harvesting) have a positive effect on hamster densities, whereas field vole densities did not impact hamster occurrence. Furthermore, parameters at the landscape level, such as the distance to the nearest forest or settlement did not affect hamster densities. Hence, our results suggest that in a simple agricultural landscape, local factors such as field management or vegetation cover have a greater impact on the common hamster than landscape-scale factors.

TALK

Are bear-dogs morphologically similar to bears and/or dogs? A preliminary morphological analysis of their cranial system during the Cenozoic

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Bear-dogs (Amphicyonidae) are an extinct caniformians group mostly found in North America, Eurasia and Africa from the Middle Eocene to the Late Miocene. Over these more than 30 Myr of evolution, they evolved a great diversity of size and ecology, including bear-like, but also canid-like forms. To date, due to their diverse morphology, the systematic, origin and evolution of this group remains unclear. Although their phylogenetic position seems to correspond to the sister group of all other caniforms, the evolutionary convergences in this group bring uncertainties to evolutionary hypotheses. In this preliminary study, we aim to test the morphological similarity between bear dogs and extant caniforms using three-dimensional geometric morphometrics on the cranial system in the various phylogenetic framework. Our sample includes 92 individuals of 82 extant and 10 extinct species of Caniformia spanning most of the ecological and systematic diversity of the clade. Our results show that bear-dogs have a more diverse morphology than bears and dogs, suggesting a greater variety of ecology and diet than previously reported. The occupation of the cranial morphospace of bear-dogs within the caniforms bridges the gap between musteloidea, bears and dogs clusters, highlighting why their cranial shape diversity has led to much debates in phylogenetic hypotheses. Future work includes making more accurate inference of the amphicyonids paleobiology using *in vivo* data on the musculoskeletal system and performance (bite force). At the light of these results, we plan to investigate the cause of the extinction of this clade in relation to the possible competition and appearance of new taxa with similar morphologies as well as environmental changes trough the Cenozoic. Ultimately, this work might shed light about the extrinsic and intrinsic factors driving their diversification and extinction, and potentially bring insights about their phylogeny.

TALK

Comparative colony dynamics and genetics of the highveld mole-rat, *Cryptomys hottentotus pretoriae* and the Mahali mole-rat, *C. hottentotus mahali*

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African mole-rats, subterranean rodents endemic to Africa, show a fascinating variation of social systems, potentially because the distribution of their geophytic food resources is habitat-specific. The average distance between food resources and their quantity correlates positively with aridity. This, as posited by the Aridity Food Distribution Hypothesis, explains sociality in arid-dwelling mole-rat species. Cooperative breeding likely evolved in arid habitats because single animals rarely find geophytes, and the clumped food resources can feed entire groups. Despite facing many challenges, certain individuals disperse to establish independent reproduction. The resulting variable number of reproductive males might cause a variation of intra-group relatedness. We trapped two *Cryptomys hottentotus* subspecies during four field excursions to two habitats with different aridity indices to compare group dynamics and population genetics using six microsatellite loci. Mahali mole-rats, *Cryptomys. h. mahali* were reproductively more prolific than highveld mole-rat, *C. h. pretoriae*. The mean number of individuals lost per original colony member from t-1 to t, called attrition rate, was 0.4 in the Mahali mole-rat, thus, double compared to the highveld mole-rat. Only the highveld mole-rat's attrition rates correlated positively with group size. Intra-colony relatedness was around 30% in both subspecies, with the mean intra-population relatedness being much smaller. Relatedness values were like one Damaraland mole-rat population despite a decreased aridity but lower than in many Damaraland and naked mole-rat populations. In conclusion, the relaxed environmental constraints had marginal effects on relatedness, but population density and life history likely synergistically affected both subspecies' group dynamics.

MARZIPAN POSTER 2

2D geometric morphometrics for species delimitation in West African shrews of the genus *Crocidura*

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The Guinean Forests of West Africa are considered a hotspot of biodiversity. In order to understand and protect this diversity, reliable taxonomic knowledge is required. The accelerating loss of biodiversity in this region calls for more efficient species identification techniques. However, species delimitation in these phenotypically rather similar taxa proves difficult without the use of DNA barcoding. Geometric morphometric analysis can be another cost-efficient approach to large-scale species identification. The complex taxonomy of the species-rich mammal genus *Crocidura* (Eulipotyphla, Soricidae), including several species complexes, can be seen as a result of high cryptic diversity within the genus. Here we focused on 36 West African species of the *C. obscurior*, *C. olivieri* and *C. poensis* complex to test the applicability of morphometric analyses to these taxa. In total, 354 specimens from different collections and localities were used, spanning a geographical distribution from Senegal to Cameroon. With a 2D geometric morphometric approach we aim to clearly delimitate the sampled species. For our analysis we applied sets of 2D landmarks and semi-landmarks on skulls and mandibles in combination with cranial and mandibular distances. Specimen age and sexual dimorphism were taken into account as factors for morphometric differences. In addition, we will test for geographical variation between sampled specimens of the *C. olivieri* complex. First statistical PC analysis revealed morphological differences between species. We still need to make sure that these differences are not merely based on allometry but reflect actual species character differences.

TALK

Fur glowing under UV and porphyrin accumulation in skin appendages

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Ultraviolet-induced photoluminescence (UV-PL) - often referred to as biofluorescence - has attracted a lot of attention recently, both from the scientific community and the public. Now reported in a wide range of organisms from diverse ecosystems, the chemical basis of UV-PL remains in most cases poorly defined, and our understanding of its potential ecological function is still superficial. Amongst mammals, recent analyses have identified free-base porphyrins as the compounds responsible for the reddish UV-PL observed in the pelage of springhares and hedgehogs. However, the localization of the pigments within the hair largely remained to be determined. We used photoluminescence multispectral imaging emission and excitation spectroscopy to detect, map and characterize porphyrinic compounds in skin appendages *in situ*. We also document new cases of mammalian UV-PL caused by free-base porphyrins in distantly related species. Spatial distribution of the UV-PL is strongly suggestive of an endogenous origin of the porphyrinic compounds. We argue that reddish UV-PL is predominantly observed in crepuscular and nocturnal mammals because porphyrins are photodegradable (and hence susceptible to 'neo-taphonomical bias'). Consequently, this phenomenon may not have a specific function in intra- or interspecific communication but rather represents a byproduct of potentially widespread physiological processes.

TALK

Seasonal bone microstructure fluctuations in *Sciurus vulgaris fuscoater* humeri: a case study using phenomics on CT-scans

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Sciurus vulgaris, the red squirrel, is a small, mostly arboreally living rodent, spread across the Palearctic. It is mostly vegetarian, feeding on plants, fungi, and seeds, and is less active in the winter months, but does not hibernate. In this lateral study, the humeri of the subspecies *Sciurus vulgaris fuscoater*, the Central European red squirrel, were analysed to uncover potential intraspecific variation between individuals found in different seasons. µCT-scans were obtained with a voxel size of 26 microns. Six bone parameters were calculated and statistically evaluated with regards to allometry and seasonal variations: total volume, bone volume, bone volume fraction, endocortical surface, cortical thickness, and average trabecular thickness.

Bone volume and endocortical thickness scale positively with bone size, bone volume fraction scales negatively, whereas cortical thickness and trabecular thickness are isometric. Seasonal differences were observed between the warmer summer and autumn months versus the colder winter and spring months for bone volume fraction, cortical thickness, proximal average trabecular separation and endocortical surface. We relate the observed seasonal variation to nutrient intake, notably calcium. These results offer a deeper understanding of intraindividual variation in red squirrels, that may be useful in further ecological, taxonomic, and paleontological research.

TALK

Some tigers may be lion to you – morphology and morphometry of the first lower molar in Pantherinae

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In Felidae, the cuspule pattern on the distal surface of the first lower molar (m1) is one feature traditionally used for discriminating species. Especially in Pantherinae it is used to distinguish *Panthera leo* from *P. tigris*, with the latter showing an additional distal cuspule. However, data from literature on Pantherinae reveal inconsistencies about the reported cuspule patterns. This is presumably due to different sample sizes, lack of standardisation and only cursorial descriptions of the cuspule.

Hence, we analysed the so far largest sample (~2000 specimens) of Pantherinae m1 which includes all extant species and four fossil *Panthera* spp. We scored the cuspule pattern as (1) one cuspule, (2) one cuspule and one additional tiny cuspule, (3) two clearly detectable cuspules, (4) more than two cuspules. Furthermore, we measured the length and breadth of m1 and corrected for size by length of the mandible.

Generally, all Panthera species show a species-specific pattern, although there is some variation. *Panthera leo* shows almost invariably score 1, while *P. onca* and *P. uncia* predominantly show score 1. In *Panthera tigris* and *Neofelis* spp. scores 2 and 3 dominate, but score 1 is also present. Only *P. pardus* shows the whole range of the score categories. In *Panthera*, there is no apparent sexual dimorphism present in the cuspule pattern. Based on m1 size, the two largest *Panthera* species (*P. leo* and *P. tigris*) are separated from the two smallest species (*P. pardus* and *P. uncia*), whilst *P. onca* overlaps with both groups. Additionally, *Panthera* and *Neofelis* can be clearly discriminated. The fossil *Panthera* species correspond in cuspule pattern and relative m1 size to their closest living relatives.

Our results suggest that the combination of characteristics of distal cuspule pattern and m1 size can be useful for identifying the fossil and extant remains of Pantherinae species.

TALK

Anatomical innovation in the evolution of shrews (Soricidae, Lipotyphla)

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Soricids (shrews) exhibit a number of anatomical novelties relative to other mammalian clades. Among the most remarkable is the double jaw joint, positioned sufficiently forward in the skull so as to overlap with the posterior ethmoidal region. Yet soricids are far from homogeneous and show a number of anatomically distinctive, supra-generic clades, not limited to crocidurines and soricines. Here, we outline results from a new matrix of hard-tissue characters in light of recent hypotheses on soricid phylogenetics. We show that, for example, non-*Sorex* soricines share a foramen ovale that passes through the posterior aspect of the lower glenoid facet of the squamosal, not medial or antero-medial to it. As a clade, soricines exhibit a distinctive pharyngeal roof, with short pterygoid hamuli emerging from ventrally flat choanal walls. Soricines generally exhibit a dorso-ventrally tall foramen magnum, paired dorsal cranial foramina, and an intracranial path of the maxillary division of trigeminal (V2) situated dorsal to the canal leading to the foramen ovale. In contrast, most crocidurines and myosoricines have a large, ventrally situated V2 canal, often associated with a fenestra in the anterior basicranium, medial to the foramen ovale. Crocidurines and some myosoricines may also exhibit an un-ossified roof to the stapedius fossa, joining the posterolateral basicranium with the space inside the parafloccular fossa. The fossil record further documents diversity in the total clade Soricidae. Among other things, it shows that some heterosoricine-grade species, which lack the pocketed coronoid and dual mandibular condyle, still had a squamosal articulation with widely divergent facets to receive the lower jaw. In sum, while shrews possess many hard-tissue features in common, they are nonetheless a diverse clade which contains several morphologically cohesive units, and they exhibit mosaic evolution relative to their non-soricid, lipotyphlan common ancestor.

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