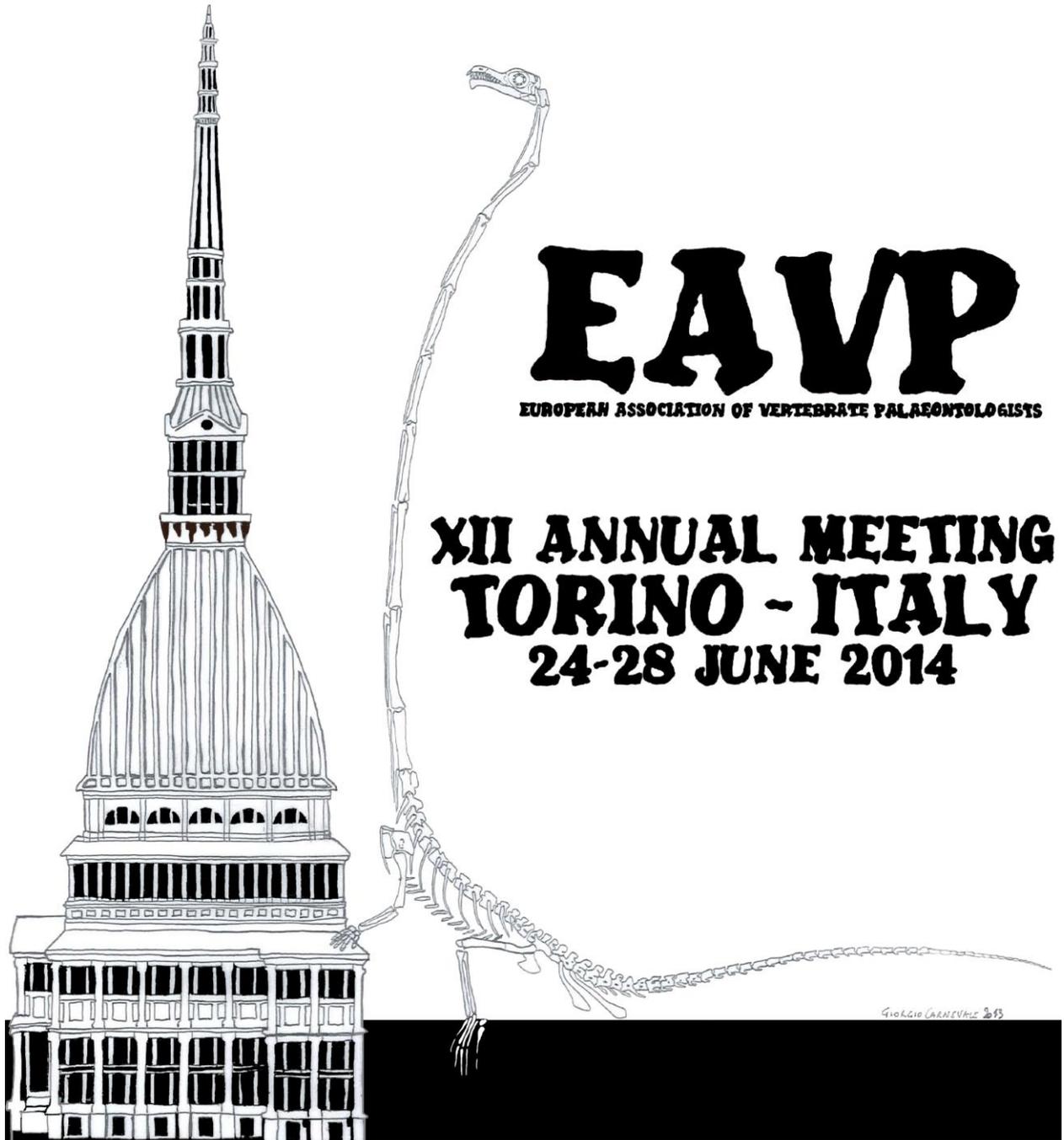


Abstract Book and Field Trip Guide



**M. Delfino, G. Carnevale & M. Pavia
(editors)**

XII Annual Meeting of the European Association of Vertebrate Palaeontologists

Torino, Italy

24-28 June 2014

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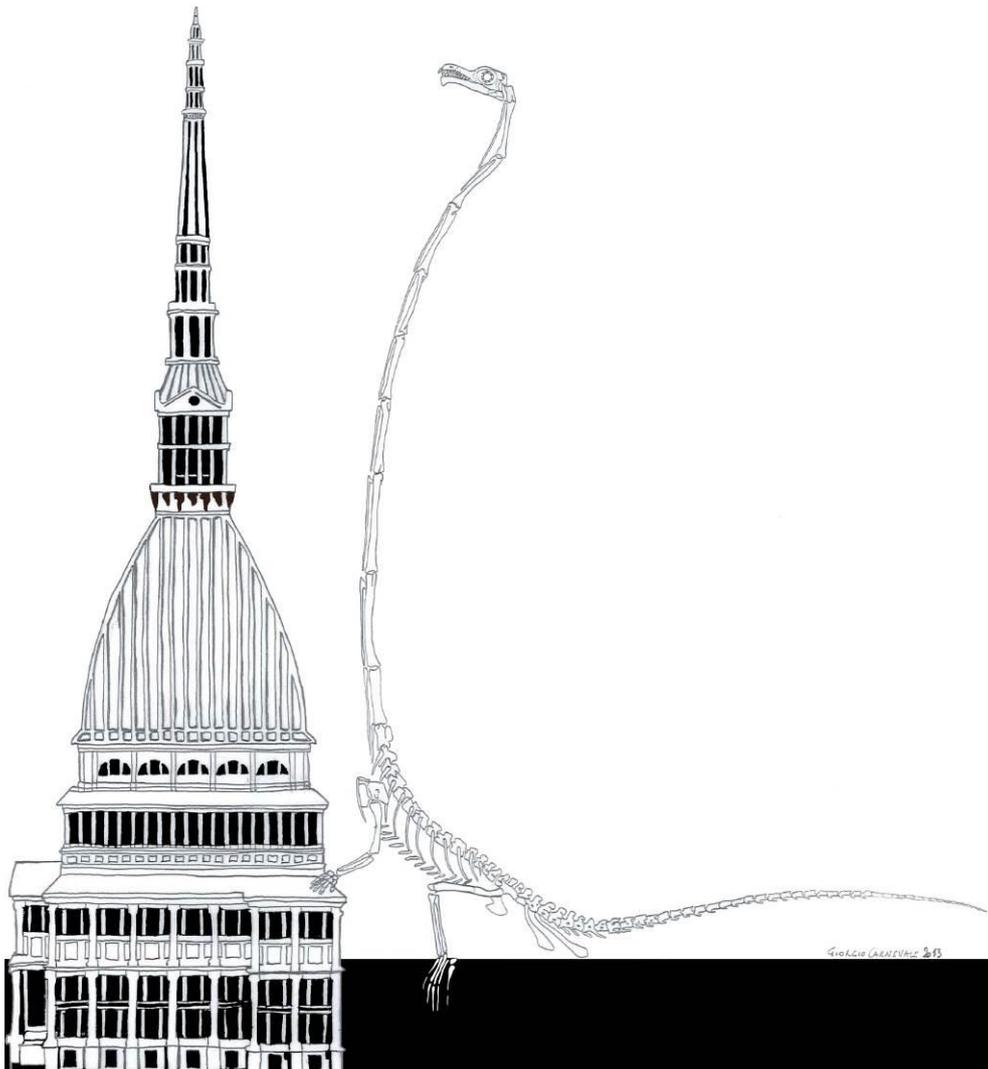


Abstract Book and Field Trip Guide

XII Annual Meeting EAVP

Torino, Italy

M. Delfino, G. Carnevale & M. Pavia (editors)



Dear attendees of the EAVP annual meeting,

First of all, welcome to Torino - and as their major car brand implies in its acronym (Latin *fiat*), I can reassure you "it will be ready".

After the first meeting of the Association in Basel more than a decade ago, we have had excellent meetings and field trips in Brno, Darmstadt, Budapest, Carcassonne, Spisska Nova Ves, Berlin, Aix-en-Provence, Heraklion, Teruel and last year in Villers-sur-Mer. However, those who are long standing fans of our group will remember our meeting in Florence in 2001, where many of our Italian colleagues attended. Those were fantastic days and I hope many more will follow this time in Torino with that special Italian flavour.

As you can see, for the first time, we will have sessions that focus on special topics, which is an indication of how our group has grown over those years. Nevertheless, I hope that all of you will follow every talk, as has been done in the past, because real scholars are always students.

Furthermore, I am happy to announce that the long lasting problem regarding our need for an EAVP journal has been resolved, thanks in particular to the intensive help of our Past President Eric Buffetaut. So please support it by sending manuscripts to *Palaeovertebrata*! It publishes original contributions on all aspects of vertebrate paleontology, including taxonomy, phylogeny, paleobiogeography, functional anatomy, biostratigraphy, paleoecology, and taphonomy – and is waiting to receive your submissions.

Furthermore, this year the Society of Vertebrate Paleontology will hold its annual meeting from November 5th to November 8th in Berlin. Jen Holland, Executive Director of the SVP has offered our EAVP members a discount for the meeting registration, so please attend and claim your benefits. And if you are not yet a member of EAVP, join us now.

And last but not least, I would like to thank Massimo Delfino and his colleagues for hosting our conference, and I am looking forward to a successful meeting with fruitful discussions and sustainable networking for the future of Vertebrate Palaeontology in Europe.

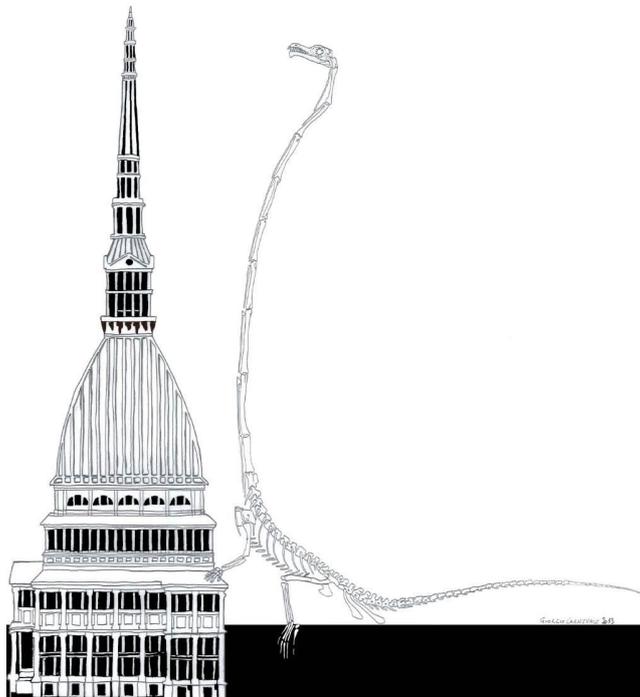
On behalf of the EAVP

A handwritten signature in black ink, appearing to read 'Ch. Meyer', written in a cursive style.

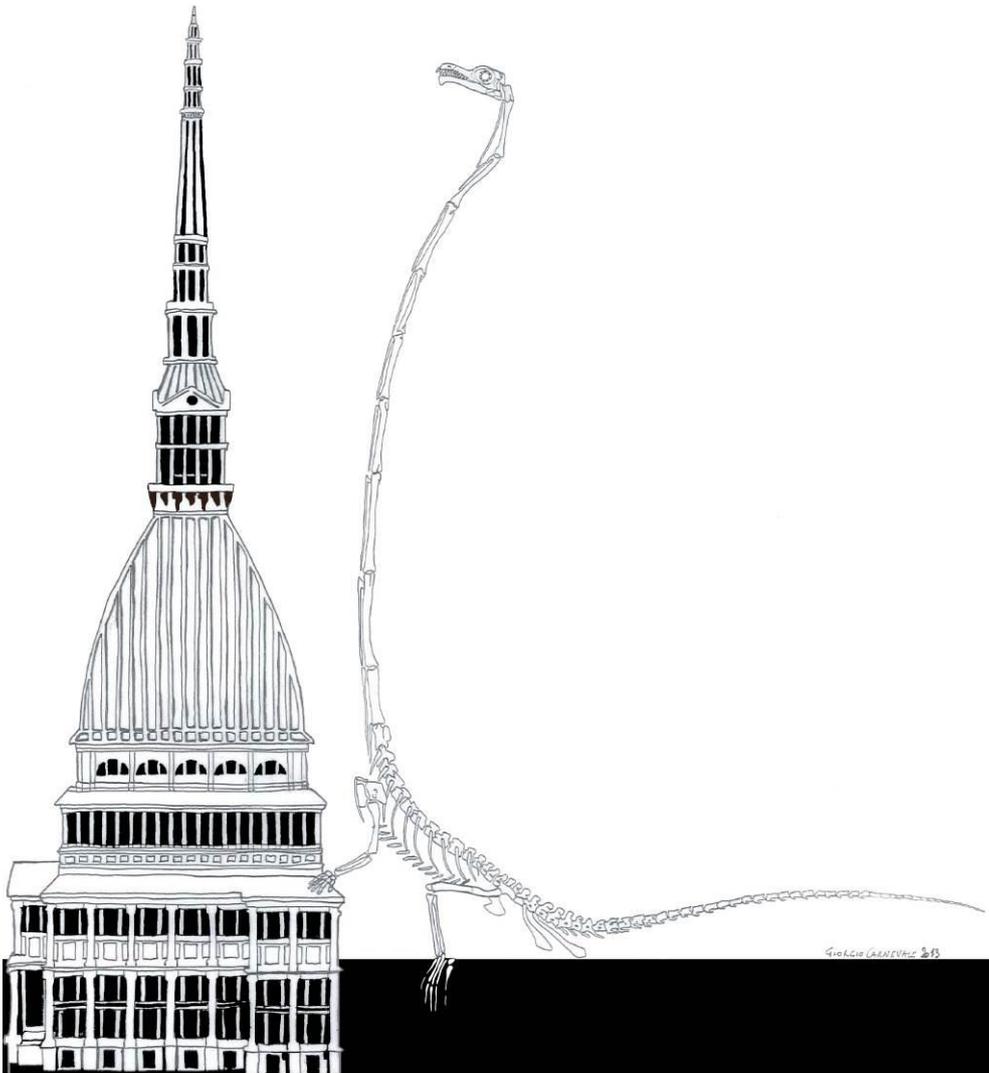
Christian A. Meyer
President

Table of Contents

Abstracts	Page 1
Fieldtrip Guide	Page 165
Index of Authors	Page 187



ABSTRACTS



CONVERGENT EVOLUTION OF TUSKS IN OLIGOCENE DOLPHINS

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Keywords: *Oligocene, Cetacea, Odontoceti, tusks, convergent evolution.*

Living toothed whales and dolphins (Odontoceti) are generally homodont and, apart from rostral proportions and number of teeth, the feeding apparatus is not very disparate. Some exceptional morphologies are the tusk of the narwhal and the highly specialized tooth shapes of beaked whales. The extinct dolphin genus *Kentriodon* (family Kentriodontidae) has been originally diagnosed by the long, slender and horizontally-projected apical teeth. However, similar tusk-like teeth have been found in at least two other contemporaneous families of fossil odontocetes: Waipatiidae, and Dalpiazinidae. A cladistic analysis of 67 taxa and 311 morphological characters showed scattered occurrences, suggesting convergent evolution of tusks. The tusks are high-crowned, conical, narrow, delicate, and horizontally directed, in skulls < 70 cm long. Most tusks were detached from the rostrum or mandibles before burial, but a juvenile and an adult dalpiazinid dolphin, and a kentriodontid, show teeth in situ, with no evidence of morphological asymmetry. Tusks grade posteriorly to less procumbent and increasingly vertical teeth in all specimens. The tusks are radiate-palmate in dalpiazinids, but parasagittal in the other taxa. Function hypotheses include display, feeding and agonism. Display is plausible, given such behaviour in extant narwhal and male ziphiids. Three fossil dolphins, however, have broken tusks, worn as if abraded by sediment during life. Tusks could have served to probe the seafloor to detect infaunal prey. Sensory adaptations of teeth and mandibles have recently been suggested for living *Monodon monoceros* (narwhal) and the extinct Pliocene porpoise *Semirostrum cerutti*. Spearing, slashing or grasping seem unlikely, given the risk of trauma in delicate crowns. One dalpiazinid has wear on the right side only, suggesting laterality (raking while swimming on one side). Fine-scale variation indicates functional diversity across families.

NEW CERCOPITHECID REMAINS FROM MONCUCCO TORINESE AND THE TAXONOMIC IDENTITY OF THE EARLIEST PAPIONINS FROM EUROPE

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Keywords: Cercopithecidae, Macaca, Mesopithecus, Late Miocene, Italy.

Two different cercopithecoid monkeys were recently reported (Alba et al. 2014) from the post-evaporitic Messinian locality of Moncucco Torinese (5.40-5.33 Ma, MN13, latest Turolian, Late Miocene), in the Tertiary Piedmont Basin (NW Italy). The colobine *Mesopithecus petelicus* is recorded by a talus, and tentatively by a proximal fragment of ulna and a male lower canine. In turn, the record of cf. *Macaca* sp. was based on two isolated teeth (I² and M₃). Here we report new cercopithecoid material from Moncucco Torinese, including a left dC¹ (MGPT-PU 130516) and a left female C¹ (MGPT-PU 130515), as well as a partial male cranium (MGPT-PU 130508). The two isolated teeth overlap in size with those of *Macaca sylvanus* ssp. and *Mesopithecus pentelicus*, and are thus left unassigned. In contrast, the new cranium is undoubtedly papionin, as evidenced by facial and dental morphology and size. Although the new cranium is distorted, it is remarkably complete, preserving most of the splanchnocranium and dentition and a large portion of the basicranium and neurocranium (except the posterior portion of the latter and the zygomatic arches). Despite wear, the molars display the typical generalized papionin morphology that is characteristic of *Macaca*, and their size fits with the upper-most range of *M. sylvanus* subspp. This suggests that the specimen belongs to a large-bodied individual of the same taxon represented by the previously published M₃ (MGPT-PU 130506) from the same locality, of smaller dental dimensions (Alba et al., 2014). Previously, Late Miocene papionins tentatively referable to cf. *Macaca* were also recorded by isolated teeth or fragmentary dentognathic remains from the roughly coeval sites of Almenara-Casablanca M (Köhler et al., 2000) and Puerto de la Cadena (Mancheño et al., 2013) in Spain. All this scarce dental material suggested that macaques dispersed from Africa into Eurasia during the latest Miocene (probably coinciding with the sea level drop associated with the Messinian Salinity Crisis), but they did not enable a secure taxonomic attribution to genus *Macaca* (which was tentatively favored on paleobiogeographic grounds). The new cranium reported here provides a wealth of information that, in the future, will allow clarifying the taxonomic status of the earliest papionins from Eurasia, with significant implications for cercopithecoid evolution and mammalian dispersal events in the circum-Mediterranean region during the latest Miocene.

Funded by the Italian MIUR PRIN 2009MSSS9L_002 (to G.P.) and the Spanish Ministerio de Economía y Competitividad (CGL2011-28681, CGL2011-27343, and RYC-2009-04533 to D.M.A.).

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THE ARAGONIAN AND VALLESIAN HIGH-RESOLUTION MICROMAMMAL SUCCESSION IN THE CALATAYUD-MONTALBÁN BASIN (ARAGÓN, SPAIN)

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Keywords: Neogene, Miocene, faunal turnover, biochronology, biodiversity.

The Calatayud-Montalbán Basin (North Central Spain) has yielded a rich and comprehensive early to middle Miocene mammal record and form the basis of the Ramblian and Aragonian stages. In the northern part of the basin, Villafeliche and Daroca areas (type area of the Aragonian), over 150 small mammal assemblages have been collected from alluvial fan and shallow-lake deposits. The stratigraphic span of these localities ranges from the uppermost Ramblian (17 Ma) till uppermost lower Vallesian (9.6 Ma) (Daams et al., 1999a). Recent studies have refined the biostratigraphic scale and enlarge the number of localities included on the analyses (Álvarez Sierra et al., 2003; López-Guerrero et al., 2011; Van der Meulen et al., 2012). Based on all these faunal information we have a high resolution micromammal succession that allows us to conceive and perform a high amount of different analyses to understand the evolution of mammal communities through long temporal periods (Daams et al., 1999b; Van der Meulen et al., 2005; Van Dam et al., 2006). The taxonomic revision of most of the micromammal taxa lets us to present here the updated information on ecological patterns of Aragonian faunas. Through the Aragonian and early Vallesian record three important faunal intervals have been recognized: an early Aragonian fauna characterized by the high diversity and relative abundance of endemic Spanish glirids combined with the progressive presence of modern cricetids coming from the East. A middle Aragonian period characterized by the decline of glirids and the rise of cricetids, with communities that are relatively poor in micromammal species. And the late Aragonian and early Vallesian characterized by an increase in species richness but still with a clear dominion of cricetids representatives. The refined taxonomic and stratigraphic information available now, allows recognizing short intervals of intense faunal turnover related with climatic singularities within the general climatic trends. These short periods represent intervals of important faunal exchanges between basins showing high degree of endemism. The new results also reflect that most of the changes were progressive intervals of community stasis being few.

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THE IMPORTANCE OF BEING A DRAWER PALAEOLOGIST

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Keywords: taxonomy, lagomorphs, Neogene, Europe.

The palaeontologist is always associated to the fascinating image of adventurous field work. Nevertheless, “excavations” in historical collections made by the so-called “drawer palaeontologists” often lead to exciting discoveries.

As far as lagomorphs are concerned, recent revisions of some European Neogene localities brought important taxonomical novelties.

Can Poncic 1 (MN9, NE Spain). References to this locality discovered in 1946 date back to the 1960s (Crusafont-Pairó & Hürzeler, 1961) however a revision of the material housed in the Institut Català de Paleontologia in 2013 allowed to discover a new ochotonid (*Lagopsis* sp., the latest European report), and additional specimens of a mysterious leporid that pre-dates the Late Miocene Leporid Datum (Flynn et al. 2013).

Ciabòt Cagna (MN13, NW Italy). The revision of the original material published by Cavallo et al. (1993) led to the discovery of *P. sorbinii*, a fact that led to reconsider the Messinian palaeodistribution of the genus *Prolagus* in the north-eastern part of the western perimediterranean area.

Mandriola (Early/Late Pliocene boundary, central W Sardinia). This is a very important locality in the framework of Sardinian palaeobiogeography. Since its first report based on material housed in the Laboratoire de Paléontologie de l’Institut des Sciences de l’Évolution de l’Université Montpellier II (Pecorini et al. 1973), Mandriola has been cited in dozens of papers related with the subject. In 2012 the revision of the material housed in the Laboratorio di Geologia e Paleontologia – Università Roma Tre led to the discovery of a leporid that raises new questions about the time and mode of the mammalian dispersals to Sardinia.

Litke2 (MN5, Hungary). The westernmost Eurasian record of the genus *Alloptox* (new species) has been reported from Litke2, a locality known since 1949 and re-excavated at the beginning of the XXI century in order to find small vertebrates (Angelone & Hír 2012 + references therein). These discoveries cast new light on the distribution and migration of lagomorphs in the Neogene of Europe.

This work received support by the Spanish Ministerio de Economía y Competitividad (CGL2011-28681), the Regione Friuli-Venezia Giulia (ICTP/Elettra EXACT Project) and partly by the RVO67985831 of the GLI AS CR.

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MORPHOLOGICAL AFFINITIES OF THE PROXIMAL HUMERUS OF MIOCENE CATARRHINES: LOCOMOTOR INFERENCES BASED ON A 3D GEOMETRIC MORPHOMETRIC APPROACH

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Keywords: humeral morphology, fossil primates, suspensory behaviors, shape analysis.

Locomotion plays a major adaptive role in shaping primate postcranial morphology during evolution, thereby enabling the inference of positional behaviors in extinct taxa. In this regard, the proximal humerus stands as key region, since its morphological disparity among taxa can be effectively linked, from a functional viewpoint, to differences in forelimb use between major locomotor categories among primates (Larson, 1995; Arias-Martorell et al., 2012). Here we provide locomotor inferences for six Miocene catarrhines by means of a 3D geometric morphometrics analysis (Bookstein et al., 1999) of proximal humeral shape, based on a comparative sample that includes proximal humeri from nine extant anthropoid genera. Body mass estimates based on allometric regressions of humeral head superoinferior diameter are also provided (Ruff, 2002, 2003). The studied extinct taxa include stem catarrhines (the propliopithecoid *Aegyptopithecus zeuxis* and the pliopithecoids *Epipliopithecus vindobonensis* and *Pliopithecus antiquus*), stem hominoids (*Proconsul heseloni* and *Nyanzapithecus vancouveriorum*), and an unassigned specimen (GSP 28062) from the Middle Miocene of Pakistan (Rose, 1989; Harrison, 2010). The latter had been previously considered a generalized arboreal quadruped (Rose, 1989), but our analysis indicates that this specimen, with an estimated body mass of 4-5 kg, has closer morphometrics affinities with the New World monkey *Lagothrix* and the extinct *Epipliopithecus*. This suggests some degree of forelimb suspensory behaviors for both GSP 28062 and *Epipliopithecus*. In contrast, and unlike a previous qualitative assessment (Ginsburg and Mein, 1980), our analysis shows that *Pliopithecus antiquus* has a very different glenohumeral morphology, much closer to that displayed by generalized arboreal quadrupeds with no evidence of suspensory adaptations, as in *Aegyptopithecus* and stem hominoids from Africa. Based on these results, the significance of the proximal humerus as a key region in order to infer the suspensory capabilities of extinct primate (Larson, 1995; Arias-Martorell et al., 2012) is further highlighted.

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DYNAMICS OF FAUNAL AND ECOSYSTEM CHANGE FROM THE SIWALIK RECORD OF PAKISTAN

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Keywords: *Miocene, biogeography, Siwalik, mammals, paleoclimate.*

Siwalik sediments and vertebrate faunas of the Indian subcontinent document ecosystem changes under different configurations of geodynamically controlled barriers and climatic change. Over the Neogene, the Siwalik faunal province, which extended from Pakistan to Myanmar, was alternately isolated or connected to Eurasian biogeographic provinces depending on changes in sea level and montane barriers. Four biogeographic modes result from the interaction of permeable versus impermeable barriers to dispersal and changing versus stable climates. Each mode leads to a unique set of macroevolutionary predictions for mammalian species and faunas. For example, the combination of permeable barriers and climatic stability should result in low rates of immigration and extinction, elevated endemic speciation, and stable ecological structure for Siwalik mammals.

The record of Siwalik mammals from 18.0 to 5.5 Ma provides a basis for evaluating whether periods of faunal change or stability correspond to the predictions for the biogeographic modes. We calculated confidence intervals on species durations and then analyzed per-capita rates of origination, extinction, diversification, and turnover for 0.5-myr intervals for large mammals (>1 kg) and small mammals (<1 kg) separately. During two intervals of permeable barriers and changing climatic conditions, small mammals and large mammals showed similar patterns of diversification: a Middle Miocene interval was dominated by high origination rates and positive diversification and a Late Miocene interval was dominated by high extinction rates and negative diversification. During a Middle Miocene interval of impermeable barriers and stable climate, large mammals exhibited stable diversity and small mammals showed modest turnover with declining diversity. During a Middle to Late Miocene interval of permeable boundaries and stable climate, large mammals showed significant turnover but little change in diversity, whereas small mammals exhibited stable diversity. The balance between immigrant origination versus endemic speciation largely matches the predictions of the biogeographic modes. These patterns suggest that changing climatic conditions affected small mammals and large mammals in a similar manner via geographic-range shifts and immigration in excess of endemic speciation. In contrast, under stable climatic conditions, small mammals and large mammals showed non-synchronous turnovers, stable diversity, and endemic speciation in excess of immigration. These contrasting patterns of faunal change and stability support the concept of multiple biogeographic modes of biotic change, which are only evident in ecosystem histories over deep time.

THE BASAL EOCENE MARINE FISH LOCALITY IN KABARDINO-BALKARIA, SOUTHWESTERN RUSSIA

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Keywords: *basal Eocene, Teleostei, Gerpegezh locality, Kabardino-Balkaria, northern Caucasus.*

Recent excavations in the Paleogene deposits cropping out along the Kheu River in the Republic of Kabardino-Balkaria, northern Caucasus (Russia) led to the discovery of a new basal Eocene fish assemblage from a sapropelitic layer deposited in response to the greenhouse conditions associated to the Paleocene-Eocene Thermal Maximum (PETM). To date, only a very peculiar member of the syngnathoid superfamily Macroramphosoidea was described from the Gerpegezh locality (Kheu River) (Bannikov and Carnevale 2012). At least two more fossil fish localities characterized by exceptional preservation originated during the anoxic event associated to the PETM, one in Denmark (Mo-Clay, Fur Formation) and the other in Turkmenistan (Danata Formation). The fish assemblage from the Fur Formation was cursorily described by Bonde (1966), with only few taxa properly documented, while the Turkmenian assemblage includes about 38 taxa of teleost fishes (Danil'chenko 1968; Bannikov 2010). The ichthyofauna of the Gerpegezh locality still has not been investigated in detail. However, a cursory survey of the material collected from the Kheu River sapropelitic layer (dated as the basal Eocene) revealed the presence of anguilliforms, clupeiforms and several percomorphs, many of which represented by larval or juvenile individuals. Unfortunately, most of the fish specimens are badly damaged by the pyrite which usually replaces the original bony substance in the sapropelitic layer. This usually makes it difficult to recognize many of the important osteological characters. Preliminary list of the basal Eocene Gerpegezh teleost fish fauna is as follows: Anguilliformes cf. Muraenidae indet.; "Opsithrissops"-like lower teleosts; Clupeidae gen. et sp. indet.; Ophidiiformes indet.; Lampridiformes cf. Lophotidae indet.; Aulostomoidei indet.; Syngnathidae indet.; *Gerpegezhus paviai* Bannikov et Carnevale, 2012; Percoidei fam., gen. et sp. indet.; Priacanthidae juv.; *Mene* sp.; *Avitoluvarus* sp.; Gempylidae gen. et sp. indet.; *Eospinus* sp.; Diodontidae gen. et sp. indet.; new family of tetraodontiforms. The composition of the fauna differs greatly from those of both Denmark and Turkmenistan, although the presence of the genera *Mene*, *Avitoluvarus* and *Eospinus* reveal certain similarity to the latter.

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A BRIEF REVIEW OF THE BRITISH ORNITHOPOD (DINOSAURIA, ORNITHISCHIA) RECORD

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Keywords: *Ornithopoda, Jurassic, Cretaceous, species-richness, taxonomy.*

The first ornithopod material discovered in the UK was found on the Isle of Wight around a decade before the naming of *Iguanodon* in 1825, though it was not fully described until two decades afterward. Since 1825, many other ornithopod taxa have been named, ranging in age from Callovian–lower Cenomanian in age. All ornithopod body fossils recovered from the UK thus far have been found in southern and central England, with a particularly rich record from the Wealden Group of Sussex and Surrey, although plausible ornithopod footprints have also been described from the Middle Jurassic of north-eastern England and Scotland.

Surprisingly, the earliest-known British ornithopod, *Callovosaurus leedsi* (Callovian: Middle Jurassic), is a member of Dryosauridae, an early diverging iguanodontian clade. More ‘basal’ ornithopods are currently unknown from the British Jurassic and earliest Cretaceous, though isolated, currently undescribed teeth from various microvertebrate faunas in the Bathonian–Valanginian hint at their presence. The only other valid Jurassic ornithopod, *Cumnoria prestwichii* (Kimmeridgian: Late Jurassic), is also an early iguanodontian.

A single mandible represents the iguanodontian *Owenodon hoggii*, which forms an important record of a Berriasian ornithopod. This taxon, and the medium- to large-bodied iguanodontians from the Lower Cretaceous Wealden Group, were until recently all lumped together into *Iguanodon*. Regarding the Wealden taxa, several species of *Iguanodon* were named historically, and distinct lower and upper Wealden faunas were recognised based on these species-level differences. This biostratigraphical distinction is still recognised, though most of the species in these faunas have been reassigned to new genera following recent taxonomic revisions. Lower Wealden (Valanginian) faunas include *Barilium* (= *Torilion*) *dawsoni*, *Hypselospinus* (= *Wadhurstia*, *Huxleysaurus*) *fittoni*, and *Kukufeldia tilgatensis* (with the taxonomic validity of the latter under debate), while upper Wealden (Barremian–lowermost Aptian) faunas contain *Iguanodon bernissartensis* sensu stricto and *Mantellisaurus* (= *Dollodon*) *atherfieldensis*. Most of these taxa are known from multiple specimens permitting at least some assessment of anatomical variation.

New discoveries and reappraisal of museum collections has also shown that the dryosaurid *Valdosaurus* was a more important component of upper Wealden faunas than previously appreciated, and it seems likely that it, or a very similar dryosaurid, was also present in the lower Wealden. Abundant specimens of the ‘basal’ ornithopod *Hypsilophodon foxii* have been recovered from the upper Wealden of the Isle of Wight, but to date mainland upper Wealden faunas have yet to yield similar ‘basal’ ornithopod material.

The British record is completed by rare records of iguanodontians and basal hadrosauroids from the ‘Cambridge Greensand’ (late Albian) and ‘Lower Chalk’ (early Cenomanian). None of the named taxa from these units can be adequately diagnosed, but they are of interest as some (e.g., ‘*Trachodon cantabrigiensis*’) represent animals very close to hadrosaurid origin. Consequently, the British record incorporates a range of taxa from basal ornithopods through to very hadrosaurid-like taxa. Southern England was clearly a hotspot for ornithopod diversity: continuing work on historical collections, analysis of new microvertebrate localities, and serendipitous discoveries of additional material are likely to increase this diversity further.

FOSSIL TRAGULIDS OF THE SIWALIK FORMATIONS OF SOUTHERN ASIA

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Keywords: *Tragulidae*, *Siwaliks*, *Dorcabune*, *Dorcatherium*, *Siamotragulus*.

Tragulids are common in the Early Miocene through Pliocene Siwalik faunas of the Indian Subcontinent where they are represented by as many as 17 species. Recently large collections of Siwalik fossils have been made by collaborative projects involving Harvard University, the University of Arizona, the Geological Survey of Pakistan, and the Pakistan Museum of Natural History. The collections comprise over 3700 specimens, including dental, cranial, and postcranial elements. Most of this fossil material is from northern and southwestern Pakistan and comes from well-dated stratigraphic sections. The oldest definite tragulids are from the Early Miocene Vihowa Formation and are around 18.7 Ma, while the youngest are in the Pliocene Tatrot Formation and are 3.3 Ma.

The fossil tragulids of the Siwaliks differ from the extant species in a number of ways. They have a considerably wider range of body sizes, ranging from 1 to nearly 76 kg. Consequently the small species overlap with the smallest species of *Tragulus*, while the large species are the weight of medium size bovids and cervids. Siwalik tragulids are also relatively common in the fossil collections and they are species rich. Although the status of some described species is uncertain, preliminary analysis indicates there are additional undescribed species. Three genera are known and typically at least four species co-exist at any one time during the Miocene.

The history of the south Asian tragulids can be linked to documented environmental changes. The Siwalik deposits formed in a large fluvial system, with extensive forested or wooded low relief floodplains having abundant cover and fruit. Isotopic analyses of tooth enamel and soil carbonates indicate the vegetation was dominated by C3 plants until 9 Ma, after which there was a shift to a more seasonal monsoon climate that experienced significant dry seasons. This environmental change is likely to have caused change in the relative abundance of tragulids and accounts for the appearance of larger as well as higher crowned species.

A NEW CONTRIBUTION TO THE INTERPRETATION OF THE BONY MASS INCREASE IN A SMALL CYPRINODONTIDAE FROM THE MESSINIAN DEPOSIT OF MONTE TONDO (RAVENNA, ITALY)

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Keywords: Pachyostosis, Teleostei, Messinian, Lagoon, Italy.

A new ichthyofauna from the late Messinian succession of M. Tondo (Ravenna, Italy), is examined. Forty *Aphanius crassicaudus*, one clupeid and five gobies specimens are described. Morphometric and meristic characters are measured and a pachyostosis index has been calculated on the small Cyprinodontidae (*A. crassicaudus*) specimens. *Aphanius crassicaudus* in the M. Tondo assemblage is represented by the two well-known messinian phenotypes (the first one with a thin skeletal structure and the second one, with an enlarged, pachyostotic skeleton) (Gaudant, 1979). Pachyostosis in *A. crassicaudus* is a bony hypertrophy homogeneously extended to the whole skeleton and it is known in other messinian eurhalyne fishes such as Gobiidae, but it is unknown among extant fish. Four gobies specimens from M. Tondo deposit are affected by pachyostosis, and one presents the thin-skeletal structure. The population of *A. crassicaudus* from Monte Tondo ranges from 11-69 mm SL, which may be considered of rather large size and considering that 72,97% of population is included in the group of 30-60 mm SL, it was well-adapted to the environmental conditions. The index of pachyostosis measured on 37 specimens suggests that 37,84% were affected by osseous hypertrophy. Pachyostosis afflicts also young individuals characterized by a SL < 30 mm, sometimes in a very accentuated way (specimen MT06: SL 29 mm, Ø/l = 0,30). A comparison between the thin-skeleton individuals and the pachyostotic ones, along with data from morphometric and meristic characters, indicates the two different phenotypes belong to the same species (Gaudant, 1979); the position of the epipleurals is the only considerable difference between the two phenotypes: in the pachyostotic individuals they are positioned at the bottom of the post-cranial skeleton, close to the vertebral centra, while in the thin skeleton ones they are located on the top of the abdominal region, among the neural apophyses (MT 025). The typology of bone mass increase is discussed herein; radiographic analyses, histological sections and the quantitative analysis of microelements (carried out by the inductively coupled plasma mass spectrometry – ICP - MS) performed on pachyostotic and thin bones of *A. crassicaudus* from M. Tondo, are compared to those of new specimens of *A. crassicaudus* coming from the Messinian deposit of M. Castellaro, Pesaro (central Italy), with a determined stratigraphic position. Finally *A. crassicaudus* was a dominant constituent of the mediterranean estuarine/lagoon fish assemblages during the Messinian. The presence in the M. Tondo fossil assemblage of other eurhalyne taxa (*Gobius* and Clupeidae) allows to hypothesize a partially confined coastal lagoon environment (Carnevale, 2008). In addition the presence of some pachyostotic specimens (*A. crassicaudus* and some gobies) indicates a stressed biological environment during the post evaporitic phase of M.S.C.

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CARNIVORES FROM THE MIDDLE VILAFRANCHIAN SITE OF COSTE SAN GIACOMO (ANAGNI BASIN, CENTRAL ITALY).

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Keywords: *Canis, hyaenids, middle Villafranchian, Pleistocene, Coste San Giacomo.*

The mammal assemblage of the palaeontological site of Coste San Giacomo is crucial in understanding the palaeoecological conditions in the southern Europe during the Early Pleistocene. Recent excavations and fieldwork (2013 and 2011 respectively) allowed to unearth new fossil remains, in particular microvertebrates bones. Bellucci et al. (2013) considered magnetostratigraphy, pollen and small mammal biochronological data and confirmed the position of the Coste San Giacomo Faunal Unit, focusing the possible age of the mammal assemblage around 2.1 Ma, in a reversed phase before the base of the Olduvai chron.

In this work we present the new data of the carnivores. The guild at CSG consists of a machairodontine felid of the genus *Homotherium*, hyaenids (few isolated teeth intermediate in size between *Pliocrocuta perrieri* and *Pachycrocuta brevirostris*) two species of canids, *Canis* sp. and *Vulpes* cf. *alopeoides*, and the bear *Ursus* cf. *etruscus*. The scavenging activity of hyaenids is also documented extensively by more than 200 coprolites, as well as by many fossil bones showing gnaw marks and bite marks.

The occurrence of the genus *Canis* has a particular biochronological and palaeoenvironmental significance, the spread of this pack hunter marks the beginning of the so-called “wolf event” (Azzaroli, 1983) enjoying an extraordinary development during this period.

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A NUMERICAL SCALE FOR QUANTIFYING THE QUALITY OF PRESERVATION OF VERTEBRATE TRACKS

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Keywords: vertebrate ichnology, preservation, autopodium morphology, numerical scale.

Vertebrate ichnology has usually been based on qualitative descriptions of specimens, from its beginning (e.g. Hitchcock 1836) to the most recent papers (e.g. Milàn, 2011; Lockley et al. 2012). At the same time, considerable effort has gone into illustrating footprint and trackway morphological features (e.g. Thulborn 1990). In recent years, new threedimensional digitizing technologies such as laser-scanning and close-range photogrammetry (e.g. Petti et al., 2008; Falkingham 2012) and methods (e.g. geometric morphometrics) have made possible more objective, quantitative approaches to vertebrate ichnology (Rasskin-Guttman et al. 1997; Azevedo-Rodriguez and Santos 2004). However, quantitative shape analyses need to be based on data of high quality, and comparisons are best made between tracks comparable in quality of preservation. Thus determining which footprints constitute the most reliable sample for quantitative analyses is fundamental for the progress of ichnology.

We introduce here a numerical scale to quantify the quality of preservation of vertebrate footprints, based on morphological details present in the prints. As “preservation” we mean the record of morphological features which can be related to the anatomy of the trackmaker’s autopodium. Whether the diagnosable features of a footprint are due to the rheological features of the substrate or to the weathering of the lithified surface is not the aim of this scale.

The numerical grades conceptually arise from theoretical assumptions about the fossil record, and also from experimental observations footprints of the extant emu (*Dromaius novaehollandiae*). The numerical scale is ordinal in character, reflecting progressively better preservation of morphological details and is set to be applicable both to bipedal and quadrupedal trackmakers. Values range from 0 (the worst prints, occurring only as aligned depressions) to 3 (the best preserved prints), plus some coded letters to introduced to specify the occurrence of certain morphological or preservational features (e.g. skin impressions).

The aim of this numerical scale is to provide a consistent means of assessing the preservation quality of footprints, both for future descriptions and for retroactive characterization of previously published material, thus facilitating application of new, quantitative methods of footprint shape analysis to previously described dinosaur tracks. The use of such a scale is not intended to replace qualitative descriptions of morphology, but rather to integrate it with a numerical value, resulting in improved understanding of the morphological features present in the specimens.

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BEHAVIOURAL INFLUENCES IN TRACK FORMATION IN MODERN RATITES

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Keywords: *bird ichnology, behaviour, ratites, ostrich.*

The study of footprints and trackways, modern and fossil, allows the insights of several aspects of trackmaker's locomotion (e.g. biomechanics of the limbs), ecology (e.g. living environment) and behaviour (e.g. gregariousness) (Falkingham, 2014). Track morphology is determined by the complex interaction between the sediment and the trackmaker, and in the case of fossil prints lithification and weathering processes, but whereas geological characteristics can be easily compare between fossil and modern record, those features belonging the behaviour of the trackmaker are very difficult to detect. Distal metatarsal impressions are quite common in dinosaur tracks and, a part for resting traces, they are considered to be generated by the sink of the foot into a soft sediment. However, it may not be so simple.

Preliminary results on direct observations on modern ratites (ostriches) has highlighted a strong behavioural component in the formation of metatarsal impressions. Experiments were made with juvenile and adult ostriches walking in the same sediment (a silty fine sandstone). The yard substrate was raked and, with the adult ostrich part of the area was then pressed in order to create a different substrate response to pressure. The animals were left free of walk in the yard and then allowed to exit from it. The surface was photographed and photogrammetric 3D models of the whole surface and of better footprints generated and scaled using Photoscan Pro®. The models were imported in Innovmetric PolyWorks® to generate contour-lines, false-colour depth maps and to make comparison among the traces.

Despite walking on loose substrate, juvenile ostrich's tracks never show metatarsal impressions, even in the deepest tracks. A different situation occurs with the adult: metatarsal impressions are randomly present among the footprints, with any clear relationship with the gait or the compactness of the substrate. Such impressions, in fact, occur both in deeper and shallower tracks, on left and right pes, on loosed or pressed substrate, both when standing and walking.

Although these data are preliminary, it is already clear the great influence that the behaviour or even the mood of the trackmaker can have in the trace formation. This aspect is, of course, not only related to the metatarsal impression bur can potentially affect any morphological feature of a trace e.g. absence/occurrence of digits, digital angle variations, width of a trackway

Further investigations are already being carried out with other ratites to increase the case study and sort out a closer relation between behaviour and trace formation.

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TIMING AND ICHNOTAXONOMY OF THE OLDEST DINOSAUR TRACKS FROM THE SHORES OF THE NORTHERN TETHYS (ITALY, SWITZERLAND)

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Keywords: dinosaur tracks, Late Triassic, Dolomites, Italy, Switzerland.

Bones and tracks of Dinosauriforms are known from the Middle Triassic, dinosaur remains however occur in the Late Triassic (Carnian) after the Carnian Pluvial Event (Furin et al., 2006). Dinosauriform tracks and those of possible dinosaurs are reported from the Travenanzes Formation (Carnian; Bernardi et al. 2013). Other Late Triassic tracksites are known from the terrestrial sediments of the Polish Tomanová Formation (Niedźwiedzki et al., 2011) and the tidal flat deposits of the Dolomia Principale Formation (DP)/Hauptdolomit Group (HDG). Several sites have been reported in the last years especially from the Italian Dolomites and Carnic Alps (Mietto, 1988; Belvedere et al., 2010; Petti et al., 2013; Dalla Vecchia and Mietto, 1998; Marzola and Dalla Vecchia 2014) and few from Switzerland (Furrer, 1993; Meyer et al., 2007; Meyer et al. 2013). The variable thickness of the formation, its monotony, and the lack of index fossils, prevent accurate precise biostratigraphic dating; only one dolomitic track locality (Mt Pasubio) is in situ, and conodonts indicate a Late Albian age (Belvedere et al., 2008). Although hardly applicable to any other Italian sites, this age is comparable to that of the Swiss tracksites.

The tridactyl ichnofauna are very similar and contains small (*Grallator*-like) and large footprints (*Eubrontes*-like), while some differences occur in the quadrupedal tracks. The Swiss record presents some rounded and flat prints resembling those of advanced sauropod, while quadrupedal tracks from the Norian of Italy (Mt. Pelmetto) are smaller, but the poor preservation prevents a precise identification. However several Swiss localities (HDG) reveal trackways of large quadrupeds that have a close affinity to *Tetrasauropus* and therefore to a possible prosauropod origin. Most are the result of a bipedal locomotion, however one trackway shows the presence of manus impressions, which is particularly rare within prosauropods. This evidence is corroborated by the digital reconstructions of prosauropod that show them as primarily bipedal animals (Mallison 2010). Here we present a comparison of the two (almost) coeval ichnofaunas from the Northern Tethys which present some of the oldest dinosaur tracks worldwide. Large tridactyl tracks are present in several sites and seem to represent the oldest evidence of large theropod dinosaurs in the Triassic.

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THE EVOLUTION OF PETROSAL AND LABYRINTHINE CHARACTERS IN PALEOGENE HYRACOIDEA (MAMMALIA, AFROTHERIA)

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Keywords: Hyracoidea, inner ear, low frequency, phylogeny, Microhyrax.

The crucial role played by petrosal and inner ear characters for comparative anatomy, systematic, and phylogenetic reconstruction in mammalogy has long been emphasized. However, to date, with the noticeable exception of *Seggeurius*, the ear region anatomy of Paleogene hyracoids remains largely unknown (Benoit et al., in prep). Excavation campaigns in North Africa (Algeria, Tunisia) conducted by the Paleontology Laboratory of Montpellier recently led to the discovery of new hyracoid skulls that preserved the ear region and isolated petrosals. These cranial remains belong to some of the oldest hyracoid species yet known. Their petrosal and inner ear morphology was analysed and compared using X-ray microtomography (CT-scan) and a cladistic analysis. These analyses show that the petrosal morphology of stem hyracoids distinguishes from those of other stem Paenungulata (Sirenia and Proboscidea) only by the absence of a secondary common crus (i.e. the absence of a fusion between the lateral and posterior semicircular canals of the inner ear). This suggests that the loss of this character taken place earlier than in other paenungulates, maybe during the early Eocene. *Seggeurius* and *Helioseus* differ from all other Paleogene and extant hyracoids by the presence of a stapedial sulcus on their petrosals, which testifies to the retention of a fully grown stapedial artery in these basal species. They also display, with *Titanohyrax* cf. *tantulus*, a rather flattened cochlear canal that coiled on less than 2 full turns. In contrast, the cochlear canal of *Microhyrax* and extant hyracoids completes more than 3 full whorls. With 2.5 turns, the cochlea of '*Mixohyrax*' from the Oligocene of the Fayum is intermediate in this respect. This suggests that the auditory capacities of hyracoids evolved toward an increased sensitivity to low frequencies (West, 1985). This hypothesis is supported by the estimation of the low-frequency hearing limit of these species (based on the radii ratio, see Manoussaki et al., 2008) which suggests that *Titanohyrax* cf. *tantulus*, *Helioseus* and *Seggeurius* would not hear sounds below 600Hz. Though imperfectly sampled to test this hypothesis, it seems that the adaptation to low-frequency hearing in hyracoids is not correlated to the presence of a mandibular fossa. Finally, analyses revealed that the two petrosals assigned to *Microhyrax* share numerous derived traits with those of Procaviidae. This supports a surprisingly high position of this taxon in the phylogenetic tree of hyracoids, which suggests that *Microhyrax* would in fact be more derived than previously though (see Tabuce, this volume). Whatever the phylogenetic position of *Microhyrax*, it remains that the morphology that characterises the inner ear of extant procaviids already existed since the early Eocene, contemporaneous with other, more primitive, forms. Given the large discrepancies of body mass between those species, the similarity of the vestibular apparatus between *Microhyrax* and extant procaviids are difficult to interpret in term of locomotion.

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THE ORIGIN AND EARLY RADIATION OF ARCHOSAURS: INTEGRATING SKELETAL AND FOOTPRINT RECORD

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Keywords: track record, body fossil record, total evidence, Late Permian, Early Triassic.

During the Mesozoic, archosaurs became the most successful vertebrates on land, radiating into virtually all habitats. The crown group, Archosauria, comprises Crurotarsi (all forms closer to crocodiles than to birds) and Avemetatarsalia (all forms closer to dinosaurs and birds than to crocodiles), which together constitute the most diverse clade of extant Amniotes with about 10,000 species. Both palaeontologists and molecular biologist seek for a better understanding of archosaur early evolution, and especially of its timing, given that our knowledge of the macroevolutionary history of this group depend on a reliable understanding of its beginning. A better knowledge of early archosaur palaeobiogeography could provide hints into plesiomorphic ecological preferences of early forms and, if compared with an independent source of data, my reveal biases in the record. Not list, geographical distribution of fossil localities may help predicting future discoveries thus helping focusing our research efforts.

The fossil record has documented numerous stem group archosaurs of Permian and Triassic age: protorosaurids, proterosuchids, erythrosuchids, euparkeriids, doswelliids, proterochampsids and phytosaurs. The origin and the early diversification of archosaurs can therefore be investigated only by looking at the paleontological evidence which should comprehend, if possible, all available source of information.

The possible contribution of trace fossils, however, has never been taken into account when studying the origin of archosaurs. Trace fossils are famously more abundant than body fossils, and may be preserved in environments not conducive to the preservation of bone, but former ichnological investigation, often based on extramorphological (substrate-related) rather than anatomical features, prevented many researchers from considering the track record as a reliable source of data. Only recently, studies appeared that analyse trackmaker identity based on cladistic criteria such as synapomorphies of autopodia as reflected in the footprints. By using a cladistic approach, trace fossil occurrences, can in fact be used as a reliable source of data in macroevolutionary studies on biomechanics and locomotion, palaeobiogeography and palaeoecology, timing and chronology and other fundamental paleobiological aspects.

In this communication we review the Late Permian and Early Triassic archosaur record considering both ichnological and skeletal records. We newly report the presence of archosaur footprints in Upper Permian deposits of the Southern Alps (Trentino - Alto Adige) using a strictly synapomorphy based approach for their identification. Being the oldest archosaur footprints documented globally we discuss their significance in the light of the oldest skeletal taxa, which have comparable age. Ichnological data suggest that the first radiation of archosaurs in the Late Permian was more diverse than previously known, and included groups thus far not documented by body and ichno fossils before the late Early Triassic. Furthermore we integrate track and bone records for the Early Triassic highlighting the increased knowledge deriving from complementary evidence. We suggest that the large body size evident in some Early Triassic archosaur lineages may have been inherited from medium to large Late Permian ancestors.

With this communication we provide an example of full integration of skeletal and track data with the final aim of building a holistic, “total-evidence”, understanding of archosaur early evolutionary history.

THE VENICE SPECIMEN OF THE DINOSAUR *OURANOSAURUS NIGERIENSIS* (ORNITHISCHIA, ORNITHOPODA)

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Keywords: *Ouranosaurus nigeriensis*, *Iguanodontia*, *Cretaceous*, *histology*.

The holotype of *Ouranosaurus nigeriensis* (GDF 300; housed at the National History Museum of Niamey, Niger) was described in detail by Taquet (1976), who described also a few bones from the paratype (mentioned as GDF 381). A nearly complete postcranial specimen of this dinosaur species (MSNVE 3714) is exhibited at the Museum of Natural History of Venice since 1975. It was collected in the Gadoufaoua site (Niger, Africa) by an Italian-French expedition in the early '70 of the last century and was never studied. Our preliminary investigation has shown that it is probably the paratype specimen. Here we present some preliminary information about the work in progress on this specimen. Our final aim is to describe the morphology of MSNVE 3714 and compare it with the holotype described by Taquet (1976). Furthermore, we drilled and cut some skeletal elements (femur, tibia, humerus, a rib and a dorsal neural spine) in order to study their histology and possibly get information on the life-history of the individual.

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A PARTIALLY ARTICULATED SKELETON OF A BALAENID WHALE FROM THE ITALIAN PLIOCENE (CETACEA, MYSTICETI, BALAENIDAE)

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Keywords: *Balaenidae, fossil, Italy, Pliocene.*

A partially articulated, 8 meter long balaenid skeleton is currently on exhibition in the Musei Civici, Reggio Emilia, Italy. The skeleton lacks the skull but includes both mandibular rami, a forelimb, part of the vertebral column (cervical, thoracic and parts of the lumbar and caudal portions), and the pelvis. Unfortunately, most of the diagnostic characters of Balaenidae are located in the skull and ear bones and, being these bone missing, it will be highly difficult to assign the specimen to a given genus or species. However, the specimen is interesting as its forelimb exhibits primitive features that will allow to better understand the evolution of the balaenid fin. Moreover, the beautiful preservation of the vertebral column will help understand the functional morphology of the swimming behavior in this whale. Finally, a pathology in a vertebra is detected and described. The specimen represents one of the few postcranial skeletons of Balaenidae from the European Pliocene and, for this reason, it is important in understanding the evolution of the right whale body.

**VIRTUAL BRAIN ENDOCAST OF A PLIOCENE DOLPHIN FROM
NORTHERN ITALY (MAMMALIA, CETACEA, ODONTOCETI)**

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Keywords: *brain, dolphin, fossil, Pliocene, virtual endocast.*

In The October of 2009, the partially articulated skeleton of a small-sized Pliocene dolphin was discovered by Paolo Umili and Paolo Evangelista of “La Xenophora” paleontological association. The specimen was then prepared at the Museo Geologico “G. Cortesi” in Castell’Arquato and is now in the collection of this institution. The exquisite preservation of the skull allowed a detailed CT scan analysis that revealed details of the internal structures of the skull cavity and allowed the virtual reconstruction of the ear bones (still covered by matrix) and of the brain surface. Once the brain surface was available, a comparative study was undertaken to understand the phylogenetic and taxonomic affinities of the specimen and general neural characters of the brain. These data are presented and discussed in the context of cetacean brain and skeletal evolution.

A LARGE BALAENOPTERID WHALE FROM THE PLIOCENE OF ITALY (CETACEA, MYSTICETI, BALAENOPTERIDAE)

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Keywords: *Balaenopteridae, Campore, fossil, Pliocene, Italy.*

A 10 m long balaenopterid skeleton is on exhibition in the Museo Paleontologico “Il Mare Antico”, Salsomaggiore Terme, Emilia Romagna, northern Italy. The specimen is from a quarry that is Pliocene in age. It represents the only Pliocene mysticete from the Salsomaggiore area that is rich, on the contrary, in Tortonian mysticete remains. It includes an articulated series of thoracic, lumbar and caudal vertebrae, fragments of the neurocranium, tympanic bullae, humerus and a number of rib fragments and neural spines. Two white shark teeth are found in close association with the skeleton. The tympanic bulla supports the inclusion of this specimen within Balaenopteridae but the poor preservation of the skull (that is still to be completely prepared) prevents the assignment of the specimen to a given taxon. The length of the caudal section of the vertebral column strongly suggests a total body length of around 15 m. This body length estimation suggests that this whale represents one of the longest Pliocene whales discovered up to now.

**THE FIRST WELL PRESERVED CETOTHERIID SKULL FROM THE
MIOCENE OF PIEDMONT, NORTHERN ITALY (CETACEA, MYSTICETI,
CETOTHERIIDAE S.S.)**

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Keywords: *Cetotheriidae*, fossil, *Miocene*, *Mysticeti*, *Tortonian*.

A well preserved Cetotheriid specimen was found in the Tortonian outcrop in the vicinity of Alba, Piedmont, northern Italy. The specimen includes the skull, parts of the mandibular rami, some ribs and the natural casts of the vertebrae. The morphological characters of the skull include long ascending processes of the maxillae that meet along the midline posteriorly to the nasofrontal suture and reduced exposure of the parietal at the cranial vertex. These characters support the inclusion of the specimen in the family Cetotheriidae. The specimen lacks postparietal foramen and this precludes its inclusion in *Herpetocetus*. Characters of the skull suggest affinity with *Cetotherium*. Before the discovery of this specimen, Cetotheriidae were widely known from Belgium, Holland, Russia, Japan and United States but their presence in the western Mediterranean was only suggested by fragmentary remains of ear bones from the Late Miocene of central Italy. This new and well preserved specimen will be of great help in deciphering the phylogenetic relationships of Cetotheriidae and the paleobiogeography of this family in the Miocene and Pliocene.

AMPHIBIANS AND SQUAMATE REPTILES FROM THE MIDDLE TO LATE PLEISTOCENE OF BELGIUM

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Keywords: herpetofauna, paleobiogeography, Middle to Late Pleistocene, Northwestern Europe.

Studies of the Pleistocene herpetofauna have been relatively scarce in Belgium. To our knowledge, up to now, only two Late Pleistocene sites have been studied, the Marie Jeanne and Walou caves, which have only delivered anuran remains. The Marie Jeanne cave (Hastière-Lavaux, Namur, Belgium) delivered the following anurans: *Bufo bufo*, *Bufo* cf. *calamita*, *Rana (ridibunda)* sp. and *Rana temporaria* (Ballmann et al., 1980); and the Walou cave (Trooz, Liège, Belgium) yielded *Bufo* sp. and *Rana* sp. (De Wilde, 2011). We present here the fossil herpetofauna from the Middle and Late Pleistocene of two connected caves: Scladina and Sous-Saint-Paul (Sclayn, Province of Namur, Belgium). The amphibians and squamate reptiles are represented by one salamander (*Salamandra salamandra*), three anurans (*Pelodytes punctatus*, *Bufo bufo* and *Rana temporaria*), two lizards (*Lacerta* cf. *agilis* and *Anguis fragilis*) and two snakes (*Zamenis longissimus* and *Vipera berus*). The occurrence of the common parsley frog (*Pelodytes punctatus*) and the Aesculapian snake (*Zamenis longissimus*), which are not currently represented in Belgium, is of particular interest, suggesting that their range repeatedly contracted and then expanded again over the course of the Pleistocene. Scladina also represents one of the northernmost fossil mentions for the fire salamander (*Salamandra salamandra*) although it is within its current distribution in Europe. Finally, the presence of the European adder (*Vipera berus*) is well attested in Scladina whereas today this snake is infrequent and classified as endangered in Belgium.

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PALEOHERPETOLOGY AND HUMAN PALEOECOLOGY: THE CASE OF DMANISI (EARLY PLEISTOCENE, GEORGIA)

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Keywords: *herpetofauna, paleoclimate, paleoenvironment, Lesser Caucasus.*

Up to now, Dmanisi (Georgia, Lesser Caucasus), with an age of ca. 1.8 Ma (Gabunia et al., 2000; Lumley et al., 2002), is the oldest Early Palaeolithic site discovered out of Africa and at that time has delivered over 40 hominin remains including teeth, mandibles, complete skulls and postcranial elements (e.g. Gabunia et al., 2000; Lordkipanidze et al., 2007, 2013) in direct association with faunal remains (large and small vertebrates) and numerous lithic artifacts (Gabunia et al., 2000; Lordkipanidze et al., 2007; Agustí and Lordkipanidze, 2011). Given the importance of this discovery, every effort has been made to reconstruct the landscapes where these hominins once lived. New amphibian and reptile remains coming from the 1991-2009 excavation campaigns of Dmanisi (level B1) have been studied and represent at least six taxa: a green toad (*Bufo* gr. *B. viridis*), the Greek tortoise (*Testudo graeca*), a green lizard (*Lacerta* gr. *L. viridis*), a four-lined snake (*Elaphe* gr. *E. quatuorlineata*), an indeterminate colubrid (Colubridae indet. probably *Coluber* s.l.) and a water snake (*Natrix* sp.). As these taxa are not extinct and their ecology can be directly studied, they can contribute to the reconstruction of the landscape and climate. By applying the Mutual Climatic Range method to the amphibian and reptile assemblage, we show that climate was warmer and dryer than today, with a stronger contrast in the rainfall regime during the year. From a paleoenvironmental point of view, amphibians and reptiles suggest the predominance of arid environments, from steppe or semi-desert to open Mediterranean forest, with stony or rocky substrate and bushy areas. The presence of permanent aquatic environments is also documented.

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THE ICTIOFAUNA FROM THE LATE EARLY PLEISTOCENE SITE OF BARRANCO LEÓN (GUADIX-BAZA BASIN, SE SPAIN)

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Keywords: Barranco León, Guadix-Baza Basin, Early Pleistocene, ictiofauna, Cyprinidae.

The Guadix-Baza basin is located in the Betic Ranges (south of Iberian Peninsula) and cover Mesozoic rocks. This basin was filled by marine rocks during parte of the Miocene and continental infill was active until middle Pleistocene. The Plio-Pleistocene basin infill is build up by alluvial and fluvial Guadix Formation (Viseras, 1991) while the lacustrine and palustrine formations are those of Baza, Gorafe-Huélago and Sola (Vera, 1970). The early Pleistocene archeo-paleontological site of Barranco León (Guadix-Baza Basin, SE Spain) is located in the shallow lacustrine areas close to the basin margin and records one of the oldest hominin occurrence in Europe (Toro *et al.*, 2013) and great number of stone tools and one human tooth has been recovered with abundant fauna of large and small vertebrates.

This paper deals with the study of the ictiofauna, which has been scarcely analyzed up to now in this site (Doadrio & Casado, 1989; De Marfà, 2007). The studied fish remains were recovered bye sieving-washing during 2010-11's excavation campaigns and corresponding to the levels D1 and D2 (both belonging to the lateearly Pleistocene, at. ca. 1.4 My). All remains recovered corresponding to the familiy Cyprinidae with an optimal degree of conservation. This study improves the knowledge about the palaeogeography and palaeoclimatology during the early Pleistocene on the Guadix-Baza basin.

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THE GENUS *ALLODAPOSUCHUS* (CROCODYLOMORPHA, EUSUCHIA): FROM BASAL EUSUCHIA TO CROCODYLIA

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Keywords: *Eusuchia*, *Crocodylia*, *Allodaposuchus*, *Maastrichtian*, *Spain*.

The clade of eusuchian crocodylomorphs are composed of several stem taxa, such as hylaeochampsids and the genus *Allodaposuchus*, and the crown *Crocodylia* containing the three major extant lineages (*Crocodyloidea*, *Alligatorioidea* and *Gavialoidea*). This clade probably originated in the northern continents (North America and Europe) at the the Early Cretaceous (Buscalioni, 2003; Puértolas-Pascual *et al.*, 2014).

The systematics of some basal eusuchians is controversial, especially due to their fragmentary nature and the lack of postcranial record for the majority of species. For instance, while some analyses place the genus *Allodaposuchus* and *Hylaeochampsidae* as a sister taxa of *Crocodylia* (Delfino *et al.*, 2008; Puértolas-Pascual *et al.*, 2013), others suggest that *Allodaposuchus* was related to the clade *Alligatorioidea* + *Crocodyloidea* (Puértolas *et al.*, 2011).

Recently, new remains attributed to the genus *Allodaposuchus* have been discovered in the lower Tremp Formation materials from the Fumanya area (lower Maastrichtian, northeastern Iberian Peninsula). They consist of a partial skull and numerous postcranial elements belonging to both axial and appendicular skeletons. Thus, it represents the most complete postcranial material known for *Allodaposuchus*.

Phylogenetic relationships of the genus *Allodaposuchus* have been explored including morphological data provided by the new specimen. Characters were codified following Brochu (2011) and analysed by maximum parsimony using TNT. Eighty-five taxa were used as ingroup, and *Bernissartia fagesii* as outgroup. We performed three phylogenetic analyses: 1) cranial characters only; 2) cranial and postcranial characters; 3) phylogenetic analysis under constraints with whole characters, forcing *Allodaposuchus* + *Hylaeochampsidae* appearing together. The first phylogenetic analysis places the Fumanya specimen into the genus *Allodaposuchus*, as sister taxon of hylaeochampsids, at the base of *Eusuchia*, and both as a sister taxa of *Crocodylia*. This result is similar to previous analyses (Delfino *et al.*, 2008; Puértolas-Pascual *et al.*, 2014). The second phylogenetic analysis places the Fumanya specimen into the genus *Allodaposuchus*, which is placed within *Crocodylia*, in a basal position to the clade *Brevirostres* (*Crocodyloidea* + *Alligatorioidea*), more derived than gavialoids. The third phylogenetic analysis, which propose *Hylaeochampsidae* + *Allodaposuchus* as sister taxa of *Crocodylia* is less parsimonious than the second one (611 and 609 steps respectively).

The previous phylogenetic analyses placed *Allodaposuchus* at the base of *Eusuchia* (Delfino *et al.*, 2008, Puértolas-Pascual *et al.*, 2014), probably as a result of the lack of postcranial data. The result of the second analysis is according to Puértolas *et al.* (2011), and the addition of postcranial characters probably allowed the new phylogenetic interpretation. In this sense, the genus *Allodaposuchus* might be a more derived eusuchian crocodylomorph, than previously thought and this is supported by several cranial and vertebral characters. However, the discovery of more complete material helps to corroborate or refute this hypothesis.

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FIRST EARLY EOCENE LIZARD AND AMPHISBAENIAN ASSEMBLAGES FROM SPAIN

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Keywords: *Squamata, lizards, amphisbaenians, early Eocene, Paleogene.*

Lizards and amphisbaenians are an important component of European Paleogene faunas, although assemblages of the southern regions of the continent have been barely studied. The first described Paleogene associations from Southern Europe include the early Eocene assemblage of Silveirinha (MP7 of Portugal; Rage and Augé, 2003) and that from the late Eocene of Sossís (MP17a, Catalonia, Spain; Bolet and Evans, 2013; Bolet and Augé, 2014). Here, the first early Eocene lizard assemblages from Spain are reported. The fossil remains belong to a series of concentrates held at the Institut Català de Paleontologia Miquel Crusafont that correspond to several Spanish Eocene localities. For a preliminary account on the assemblages of these localities see Bolet and Evans (2010). The localities studied here (Masia de l'Hereuet, La Morera, Escarlà and additional unpublished fossil sites) are situated in the Southern Pyrenean and Ebro basins, and belong to the MP8+9 and MP10, covering a previously unstudied range of time in the Iberian Peninsula. The recovered groups include pleurodont and acrodont iguanians, gekkotans, ?scincids, lacertids, amphisbaenians, glyptosaurines, anguines and “necrosaurs”. Pleurodont iguanians are represented by *Geiseltaliellus* and an unidentified form. The acrodont iguanian compares well with the specimen from Silveirinha referred to “*Tinosaurus*” (Rage and Augé, 2003). However, the morphology of these remains (including those of Silveirinha) is no longer believed to be characteristic of “*Tinosaurus*”, whose monophyly is far from being demonstrated (Smith et al., 2011), but rather represents a widespread morphology among agamid lizards. Gekkotans are identified on the basis of poorly preserved dentary fragments. Tooth-bearing bones with slightly bicuspid teeth suggest the presence of lacertids and/or *Eolacerta*. Some sort of scincoids (most probably a scincid) are represented by fragmentary dentaries. Amphisbaenian remains are limited to vertebrae, which are difficult to assign to a less inclusive group (early Paleogene European amphisbaenians include blanids and polyodontobaenids, see Folie et al., 2013). Glyptosaurus are mainly represented by osteoderms with a characteristic tuberculated ornamentation, as well as a partial parietal. Elements referred to Anguinae include vertebrae, tooth-bearing bones, and osteoderms. The identification of “necrosaurs” is mainly based on the morphology of osteoderms, as well as the presence of tooth plicidentine. There are no marked differences between the new assemblages from Catalonia and that of Silveirinha: both contain the iguanid *Geiseltaliellus*, an acrodont of “*Tinosaurus*” type, gekkotans, bicusped forms (lacertids and/or *Eolacerta*), glyptosaurus and amphisbaenians. The presence of anguines and platynotans in the Iberian early Eocene, suggested with caution by Rage and Augé (2003), is confirmed by the new Catalan material (the latter in the form of a “necrosaur”). The possible presence of scincids, if confirmed, would represent one of the earliest records in the Paleogene of Europe. The lack of large helodermatids and varanids may be real or correspond to an artifact of sampling in screen-washed localities.

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PYRENASAURUS AND THE AFFINITIES OF LATE EOCENE LIZARD ASSEMBLAGES FROM SOUTHERN FRANCE AND NORTHEASTERN SPAIN

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Keywords: Squamata, lizard, Scincoidea, late Eocene, paleobiogeography.

Pyrenasaurus is a recently described lizard reported from two roughly contemporaneous localities at both sides (northern and southern) of the Pyrenees mountains. The holotype comes from the French locality of Escamps (MP19), and consists of an almost complete dentary preserving most teeth (Bolet and Augé, 2014). Two additional fragments of dentaries are known from the Catalan locality of Sossís (MP17a)(Bolet and Evans, 2013; Bolet and Augé, 2014). This small form is easily recognisable on the basis of its dentition morphology, characterized by anterior teeth of scincoid type, and posterior teeth labiolingually compressed, and crowns presenting a deflection in the convexity of the anterior and posterior margins of the tooth. This gives the crowns a characteristic resemblance to a short obelisk. The affinities of this new taxon are not clear. The scincoid type morphology of the anterior teeth suggests scincoid affinities and, among them, scincids are more variate and some forms fit better with the dentition and dentary shape of *Pyrenasaurus* than cordyloids. A great resemblance of late Eocene lizard faunas at both sides of the present Pyrenees is highlighted by the presence of *Pyrenasaurus*, as well as that of many other forms, including *Geiseltaliellus pradiguensis*, *Pseudolacerta*, *Gracilicerta sindexi*, *Dormaalisaurus girardoti*, *D. rossmanni*, and, potentially, other forms not identified at the genus level (gekkotans, glyptosaurus, anguines and blinids)(see Augé, 2005 for the composition of French assemblages). The affinities of faunas from both regions had already been noted on the basis of shared mammal taxa, suggesting that no physical barriers existed by that time. On the other hand, the mammal faunas from the Central and Western parts of the Iberian Peninsula are said to contain a great amount of endemic taxa, suggesting that this region was isolated from the main continent, at least for the middle Eocene and the earliest part of the late Eocene. Such assemblages are included in what is known as the Western Iberian Bioprovince (Cuesta, 1991). By the moment, regarding the lizard assemblages, it can only be stated that those from localities situated in the Southern Pyrenean basins strongly correlate with contemporaneous assemblages from France. However, new evidences for the endemic character of faunal assemblages from the Western Iberian Bioprovince will have to wait the description of their herpetofauna (lizards in particular). If enough sampling is carried out, the paleoherpetofauna has the potential to support or be against the interpretation of a great part of the Iberian Peninsula being isolated in the middle-late Eocene. Although assumptions based on the absence of a taxon are doubtful (absence is not the proof of absence), the highly characteristic teeth of forms like *Pyrenasaurus*, easily recognisable even if only one posterior tooth was preserved, may be potentially very useful in order to test this hypothesis.

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THE GEOLOGICALLY OLDEST TERRESTRIAL MAMMAL OF THE ITALIAN PENINSULA

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Keywords: *Anthracotheriidae, Late Eocene, North Italy.*

The family Anthracotheriidae (Leidy, 1869) in Italy is mainly well represented by two species *A. monsvialense* (De Zigno, 1888) and *A. magnum* (Cuvier, 1822) (Kotsakis 1984; Dal Piaz 1932). All the remains are founded in lignite quarries - which gave it the name “coal beast” - mainly located in Liguria and Veneto regions and dating from Early to Late Oligocene. The hemimaxilla discovered near Grancona breaks this homogeneous pattern because of his particular characteristic: it was founded in a calcareous-type layer associated with Naticidae. This layer is dated in the latter part of Eocene, the Priabonian age (Fabiani 1915; Papazzoni & Sirotti 1995). This datation was possible thanks to the stratigraphy information gave by an amateur that discovered the hemimaxilla during the work to repair the road connection between Corrubbio di Grancona and San Gaudenzio di Grancona nearly thirty years ago. The hemimaxilla was donate to the Archaeological and Natural Science Museum “G. Zannato” in Montecchio Maggiore (Vicenza).

The remain is poorly preserved but it is possible to recognize the P⁴ and M² which allowed the determination of the species. The size and the shape of those teeth demonstrated that is not possible to correlate this find to the *Anthracotherium* genus because the teeth are relatively smaller and neither to the *Anthracochoerus* genus because they are relatively larger and less developed.

Confronting the piece with other species found in Europe suggested the remains to be near to *Prominatherium dalmatium* (von Meyer, 1854) which is a small-medium sized anthracotherid dated in middle Eocene with similarities to *Anthracotherium* and located in Croatia (Teller 1884). The measurements are the most compatible with the Grancona's piece but still not completely convincing. For this reason the find it is determinated as *Prominatherium cf. dalmatium*. However dealing with only a couple of teeth is not enough for a more accurate attribution.

This discovery gives us important new information on the paleogeography of Italy during the Upper Eocene, testifying the presence of connection from the Balcan to the Lessini area.

The Lower to Middle Eocene Sardinian perissodactyls and marsupials (Kotsakis et al. 2005) are not here considered the oldest Italian terrestrial mammals because they don't represent the biological and geological Italian peninsula development. In fact, during the Eocene, Sardinia belonged to a completely different bio-province.

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INFERRED BITE MARKS INDICATE AN UNCOMMON TROPHIC RELATIONSHIP IN THE LATE CRETACEOUS VERTEBRATE FAUNA FROM HUNGARY

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Keywords: bite marks, bone histology, fossil bone pathology, lharkút vertebrate assemblage, predator-prey interaction.

Studying bite marks on fossil bones has recently gained more attention mostly because of its importance in inferring predator-prey, antagonistic, and/or scavenging interactions among long extinct animals. Although in the last 13 years the Late Cretaceous (Santonian) lharkút vertebrate locality (Bakony Mountains, western Hungary) has yielded a rich and diverse assemblage of fossils, so far only two specimens were found to bear tooth-mark-like pathologies on their surfaces: a plate fragment of the bothremydid turtle *Foxemys trabanti*, and a partial skull roof of the hylaeochampsid crocodylian *Iharkutosuchus makadii*. In order to assess the probability that these deformities indeed represent bite marks, the usual morphological investigation was complemented by the histological study of the intact as well as pathologic regions of these two elements. The morphology of the deformities can be described as shallow and deep pits, bisected pits, scores, and in the case of the skull roof also a hole piercing through the entire bone thickness. Most pits are arranged in rows of different orientations. Comparison of the bone histological traits between the intact and pathological areas reveals no other difference than the apparent loss of a considerable amount of bone tissue in the pathological regions most likely due to mechanical impact. Hence, the morphological and bone histological features of these pathological traits suggest that they probably represent bite marks. Post-mortem invertebrate feeding traces and microbial activity, as well as different shell diseases and infections may also result in tooth-mark-like deformities. However, they are less likely sources of the secondary alterations detected on the studied fossil bones, because no unequivocal morphological and histological features usually associated with these alternative causes can be observed in either element. Instead, morphological similarities between the pathologies present in our fossils and the experimentally investigated crocodylian tooth marks suggest that both elements bear the bite marks of a crocodylian predator with typical conical teeth. So far, four different mesoeucrocodylian taxa are known from the lharkút locality, among which only the *Allodaposuchus*-like crocodile had conical teeth and therefore might have been responsible for the bite marks in both cases. The inferred tooth marks on the dorsal surface of the *Iharkutosuchus* skull roof indicate a predator-prey interaction rarely documented between two different crocodylian taxa rather than antagonistic behaviour over common resources. Nevertheless, to draw firm conclusions and establish the basis for future investigations of fossil bone pathologies, more comparative studies are needed on the different traumatic as well as non-traumatic bone pathologies that may eventuate in bite-mark-like abnormalities.

THE BIRDS (AVES) FROM THE EARLY EOCENE OF LA BORIE, SOUTHERN FRANCE

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Keywords: Aves, Gastornithidae, Geranoididae, Eocene, France.

The early Eocene locality of La Borie is located in the village of Saint-Papoul, close to the city of Carcassonne, in southern France. This locality belongs to the formation of the 'Argiles rutilantes d'Issel et de Saint-Papoul', which corresponds to fluvio-lacustrine clay deposits. These Eocene deposits have yielded a rich vertebrate fauna, including mammals and birds (Laurent et al. 2010). The mammalian taxa found in the fossiliferous levels indicate an age near the reference level MP 8–9, which corresponds to the middle Ypresian, Lower Eocene. Here we report new avian fossils that were preliminarily described in Laurent et al. (2010).

A maxilla, a quadrate, several cervical vertebrae, a femur and two tibiotarsi are assigned to the giant ground bird *Gastornis parisiensis* Hébert, 1855 (Gastornithidae). The tibiotarsi from La Borie are very similar to the isolated tibiotarsus that was previously described from the same locality (Buffetaut 2008). The new avian remains add to the fossil record of *Gastornis*, which is known from the Paleocene to Middle Eocene of Europe, Early Eocene of China, and Early Eocene of North America (see Buffetaut 2013, for review). *Gastornis parisiensis* differs from the North American *Gastornis giganteus* (Cope, 1876) in several features, including the more ventral position of the external nares and the slender orbital process of quadrate. Two tibiotarsi and one tarsometatarsus are assigned to a new genus and species of Geranoididae. So far, this family included five genera and seven species, and was known only from the Early and Middle Eocene of the western part of the United States (Cracraft 1969; Mayr 2009). The fossils from La Borie constitute the first record of the Geranoididae in Europe.

It is well known that a great interchange of mammalian faunas occurred between Europe and North America during the Early Eocene (Mayr 2009). The presence of large flightless birds, such as Gastornithidae, on both sides of the present-day Atlantic Ocean, indicates that a land connection existed at that time (Andors 1992). In North America, the Geranoididae have been found in the same localities as *Gastornis*. Hence, the occurrence of both taxa in the locality of La Borie is not surprising.

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THE BRONTORNITHIDAE: NEW DATA ABOUT AN OLD PALAEORNITHOLOGICAL RIDDLE

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Keywords: Aves, Brontornithidae, Bolivia, Oligocene, Argentina, Miocene.

The Brontornithidae were very large terrestrial birds hitherto known only from the Miocene of Argentina, the best known species being *Brontornis burmeisteri* Moreno & Mercerat, 1891, from the Santa Cruz Formation of Patagonia. They have frequently been considered as a family of the Phorusrhacoidea, or as a subfamily of the Phorusrhacidae (Alvarenga & Höfling, 2003; Alvarenga et al., 2011), although this view was challenged as early as 1927 by Dolgopol de Saez, who placed them in an order of their own, Brontornithes. Recently, Agnolin (2007, 2013) provided additional anatomical evidence to exclude them from the phorusrhacoids and to place them among the Anseriformes. A detailed study of a relatively well preserved *Brontornis* lower jaw from the Santa Cruz Formation in the Tournouër collection at the MNHN (Paris) shows that the dentary is unlike that of phorusrhacids, being shorter and much more robust, and does not suggest a carnivorous diet (Buffetaut, 2014)..

A character separating *Brontornis* from phorusrhacids is the lack of a pons supratendineus on the cranial face of the distal end of the tibiotarsus. This was already pointed out by Dolgopol de Saez (1927), but has received relatively little attention, perhaps because both Moreno and Mercerat (1891) and Ameghino (1895) erroneously claimed that such a bony bridge is present on the tibiotarsus of the type specimen of *Brontornis burmeisteri*. When this important anatomical distinction is taken into account, the affinities of various poorly known taxa become clearer. In particular, *Liornis floweri* Ameghino, 1891, from the Santa Cruz Formation, turns out to be closely related to *Brontornis burmeisteri* (possibly a synonym), and not a junior synonym of *Phorusrhacos longissimus*, as claimed by Alvarenga and Höfling (2003).

The distal end of the tibiotarsus of a large bird from the Deseadan (Oligocene) of Salla-Luribay (Bolivia) is remarkably similar to that of *Liornis floweri* and can doubtless be referred to a brontornithid. This seems to be currently the oldest known brontornithid.

The Brontornithidae are clearly different from the Phorusrhacidae, similarities with the largest members of the latter family, such as *Paraphysornis*, being doubtless the result of convergence among large terrestrial birds. A placement among Anseriformes, as advocated by Agnolin (2007), appears to be supported by the available evidence. As a consequence, phylogenetic hypotheses based on the assumption that *Brontornis* is a phorusrhacid, such as Bourdon and Cracraft's conclusion (2011) that *Gastornis* is closely related to *Brontornis* and therefore a "terror bird", are unwarranted.

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BASAL DINOSAURIFORM AND THEROPOD DINOSAURS FROM THE MIDDLE-LATE NORIAN (LATE TRIASSIC) OF POLAND: IMPLICATIONS FOR TRIASSIC DINOSAUR EVOLUTION AND DISTRIBUTION

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Keywords: *Dinosauria, Herrerasauridae, Poland, Silesauridae, Triassic.*

Although the rise of dinosaurs during the Triassic has been the focus of extensive research, the unevenly sampled Late Triassic fossil record leaves open many questions about early dinosaur evolution and biogeography. Dinosaur (and more basal dinosauriform) remains are well documented from the Late Triassic of western North America and parts of South America, but are relatively rare in the contemporary deposits of Europe, making any new discoveries critically important. One of the most diverse dinosauriform assemblages from Europe comes from the recently described locality of Poręba in Poland. The Zbąszynek Beds are exposed at Poręba, and have a palynomorph assemblage that is characteristic for the middle–late Norian of the Germanic Basin. We evaluate several isolated dinosauriform specimens from Poręba using a synapomorphy-based approach. We provide evidence for the presence of a silesaurid, a herrerasaurid, and remains of another type of theropod (potentially a neotheropod), in this assemblage. The Poręba herrerasaurid is the first record of this rare group of primitive dinosaurs from Europe and one of the youngest records worldwide, whereas the silesaurid is the youngest record of a silesaurid from Europe. Silesaurid-herrerasaurid-neotheropod assemblages are also known from the Norian of North America, at low latitudes, and the Poręba specimens indicate that these assemblages were more widespread geographically and latitudinally than previously thought. Silesaurid-herrerasaurid-neotheropod assemblages may have been a common ecological structuring of dinosaurs during their early evolution. Their widespread distribution may indicate weak palaeolatitudinal controls on early dinosaur biogeography during the latest Triassic.

**TRACKING PRESERVATION OF BONE CELLS (OSTEOCYTES) AND
BLOOD VESSELS IN THE FOSSIL RECORD OF TURTLES.
MOLECULAR PALEONTOLOGY AND PALEOPHYSIOLOGICAL
IMPLICATIONS**

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Keywords: *turtles, osteocytes, Cenozoic, Mesozoic, preservation.*

Here we describe the morphology of osteocytes according to the bone tissue type for each of the three bone layers that comprise the turtle shell. Observations and study of osteocytes are performed using bone thin sections and demineralization of bone using EDTA. We examine osteocytes in bone from four extant turtle species to form a morphological 'baseline', and then compare these with morphologies of osteocytes preserved in Cenozoic and Mesozoic fossils. Two different morphotypes of osteocytes are recognized: flattened-oblate osteocytes (FO osteocytes), which are particularly abundant in the internal cortex and lamellae of secondary osteons in cancellous bone, and stellate osteocytes (SO osteocytes), principally present in the interstitial lamellae between secondary osteons and external cortex. We show that the morphology of osteocytes in each of the three bone layers is conserved through ontogeny. We also demonstrate that these morphological variations are phylogenetically independent, as well as independent of the bone origin (intramembranous or endochondral). Preservation of microstructures consistent with osteocytes in the morphology in Cenozoic and Mesozoic fossil turtle bones appears to be common, and occurs in diverse diagenetic environments including marine, freshwater, and terrestrial deposits. These data have potential to illuminate aspects of turtle biology and evolution previously unapproachable, such as estimates of genome size of extinct species, differences in metabolic rates among different bones from a single individual, and potential function of osteocytes as capsules for preservation of ancient biomolecules.

UNDERSTANDING THE VALLESIAN MAMMAL TURNOVER THROUGH PALEOBIOGEOGRAPHY

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Keywords: *Late Miocene, Vallesian Crisis, faunal turnover, chronofauna, paleobiodiversity.*

While most Mediterranean environments of the Late Miocene became drier and harsher, the Vallès-Penedès basin (Catalonia, Spain) continued to keep humid and forested-adapted faunas until around 9.6 Ma, including the last hominoids of Europe. To elucidate the broader context of this biogeographic and ecological singularity, we compiled large datasets of macro- (817 localities, 99 genera) and micromammals (456 localities, 107 genera). We mapped Raup-Crick similarity indices through time of all the localities to Can Llobateres 1, which represents the apex of the Vallesian faunas.

We found that the waxing of the Vallesian faunas is slightly decoupled in macro- and micromammals. For the micromammals, the first Vallesian elements are observed in Central Europe during MN5. The first similar macrofauna appeared in Central Europe in MN6, although patterns are more heterogeneous than for the micros. During MN7+8, the pattern became more defined for both groups, with a clear Eastern Mediterranean province and a Central European one, which included the Vallès-Penedès. The MN7+8 faunas showed a high similarity with the Vallesian, stemming from the many relicts the Vallesian faunas inherited from the Aragonian. At this time, the Vallesian-related macrofauna had completely spread across the Iberian Peninsula, while the entrance of the Vallesian microfauna into Iberia was restricted to the Vallès-Penedès basin, differentiating an inner Iberian province. Whereas the Vallesian faunas became widespread in Western Europe in MN9 and MN10, their geographic extent began to shrink from the east, as the more arid-adapted Pikermian faunas spread. The disappearance of the Vallesian microfauna had already culminated by MN11, leaving some scarce relicts in Central Europe. A significant part of the Vallesian macrofauna, however, remained in Iberia and Central Europe in MN11, remaining present during MN12 and MN13.

BADENIAN FISHES FROM ST. MARGARETHEN IN BURGENLAND, AUSTRIA: STRATIGRAPHIC, PALEOECOLOGICAL AND PALEOBIOGEOGRAPHICAL REMARKS

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Keywords: fossil fishes; Badenian; Central Paratethys; paleoecology; paleobiogeography.

Fossil fishes from the Badenian coralline limestone cropping out in the nearby of the village of St. Margarethen in Burgenland, in the Eisenstadt-Sopron Basin, eastern Austria are known since the first part of the XIX century. A large collection of exquisitely well-preserved fishes and invertebrates from the coralline limestone was recently accumulated during two large excavation campaigns carried out in the Kummer Quarry by the Naturhistorisches Museum, Wien, about 2 km E of St. Margarethen (47°48'01.76"N, 16°37'59.12"E). Fossil remains are represented by teleost fishes, shark teeth, crustaceans, bryozoans, echinoids, molluscs and brachiopods, preserved in finely laminated greenish-whitish calcarenitic marls that possibly were deposited in depressed area characterized by reduced water energy and surrounded by carbonate sand build-ups. The mass accumulations of fishes and the thanatocoenoses of autochthonous benthic invertebrates originated in response to repeated hypoxic events. The repeated and severe benthic hypoxic events seem to be associated to blooms of *Coccolithus pelagicus* and reticulofenestrids apparently triggered by periodic increased input of nutrients. The Late Badenian age of this Fossil-Lagerstätte has been estimated based on calcareous nannoplankton, which suggests a basal Serravallian boundary, roughly between 13.8 and 13.5 Ma. The excellent preservation of fish skeletal remains might be due to the development of a microbial film that promoted the rapid mineralization of bones and other organic components. Slightly less than thousand fish specimens (sharks, batoids and teleosts) have been analyzed, among which 49 taxa belonging to 37 families have been identified. The round herring *Spratelloides* sp., the lanternfish *Diaphus* sp. and the scorpionfish *Scorpaena prior* definitely dominate the assemblage, with more than 50% of the recognized specimens. The comparative analysis of the ecological categories reveals that the assemblage mostly consists of benthic and demersal neritic (e.g., *Boops* aff. *roulei*, *Callionymus* sp., *Calotomus priesli*, *Chaetodon* cf. *ficheuri*, *Coris sigismundi*, *Dentex* sp., *Epinephelus* cf. *casottii*, *Gaidropsarus pilleri*, *Lophius* sp., *Malacanthus* sp., *Miobothus weissi*, *Mullus* sp., *Nerophis zapfei*, *Palimphemus anceps*, *Priacanthus* cf. *croaticus*, *Scorpaena prior*, *Symphodus westneati*, *Synodus* sp., *Trachinus* sp., *Wainwrightilabrus agassizi*) and coastal epipelagic taxa (e.g., *Belone* sp., *Sardinella* sp., *Scomber* sp., *Sphyraena* sp., *Spratelloides* sp., *Trachurus* sp.), with a relatively diverse contingent of migratory pelagic and oceanic taxa (*Bregmaceros* cf. *albyi*, *Cetorhinus parvus*, *Diaphus* sp., *Merluccius* aff. *errans*)

The paleoecological analysis of the fish assemblage suggests that the deposition of the finely laminated fossiliferous calcarenitic marls occurred not far from the coastline in a moderately shallow basin surrounded by densely vegetated area and rocky reefs and remarkably influenced by the open sea. The highly heterogeneous composition of the assemblage, which is characterized by the co-occurrence of coastal, and opportunistic mesopelagic taxa, is consistent with the unstable eutrophic conditions indicated by the nearly monospecific or oligospecific blooms of *Coccolithus pelagicus* and reticulofenestrids that triggered the periodic hypoxic events.

From a biogeographical perspective, the fish assemblage from St. Margarethen exhibits a clear Atlantic-Mediterranean configuration, but also includes several taxa today restricted to the tropical waters of the Indo-Pacific and Caribbean regions (e.g., *Aeoliscus*, *Calotomus*, *Chaetodon*, *Malacanthus*, *Pristis*), representing the heredity of the Tethyan biota.

NEW CHONDRICHTHYAN ASSEMBLAGES FROM THE NEOGENE OF TROPICAL AMERICA: PALEOENVIRONMENTAL AND PALEOCEANOGRAPHIC IMPLICATIONS

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Keywords: *Early-Late Miocene, sharks, rays, paleoenvironment, paleobiogeographic.*

We report eight new chondrichthyan assemblages from the Tropical America, including the Caribbean region of the Guajira Peninsula, Colombia (Uitpa and Castilletes formations: Early-Late Miocene); Panama Canal Basin, Panama (Chagres Formation: Late Miocene); Western Venezuela (Urumaco Formation: Late Miocene) and Eastern Pacific at Bordón and Manabí basins, Ecuador (Angostura, Onzole, Canoa and Jama Formations: Late Miocene- Pliocene). These assemblages are characterized by taxa with shallow and deep-water affinities with a diversity of at least 60 taxa including the orders Hexanchiformes, Squaliformes, Pristiophoriformes, Squatiniformes, Heterodontiformes, Lamniformes, Carcharhiniformes, Rajiformes and Myliobatiformes. The assemblages from the Canoa, Castilletes, Onzole and Urumaco Formations are characterized by taxa with neritic-coastal affinities. In contrast, the abundance of taxa with Oceanic and deep-water affinities in the Angostura, Chagres, Jama and Uitpa Formations could suggest that the environment corresponds to those of the external platform-upper slope, with a deep water influence. The taxonomic commonality between faunas from the Eastern Pacific and Western Atlantic possibly is the result of the faunal interchange allowed by the presence of the marine corridors in the Panamanian area before the definitive closure of the isthmus. The Chagres Formation assemblage further indicates the existence of a marine Caribbean-Pacific connection during the latest Miocene (Messinian). These new assemblages constitute one of the most diverse associations known from the region, and our study provides a more complete view of the chondrichthyan diversity inhabiting Tropical America during the Miocene.

THE MIOCENE MAMMAL SUCCESSION IN THE VALLÈS-PENEDÈS BASIN (CATALONIA, SPAIN)

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Keywords: Iberian Peninsula, Neogene, faunal turnover, paleodiversity, paleoecology.

The Vallès-Penedès Basin is an elongated half-graben near to Barcelona (Spain) that shows a remarkably complete continental record for most of the Miocene, from about 17-19 Ma to about 7 Ma. There is only a hiatus between about 16.5 and perhaps 13 Ma, when a large part of the basin was flooded because of successive marine transgressions. Although a number of Early Miocene (Ramblian-early Aragonian, MN3-MN4) sites are known, the richest and most continuous mammal record is between 12.5 and 9 Ma, (late Aragonian-late Vallesian, MN7+8-MN10). More than 200 different sites are known from this time span, and for most of them the temporal resolution is very good. This allows studying diversity dynamics and ecological structure during this interval in detail, particularly for well-known groups such as rodents. The late Aragonian mammal assemblages are diverse and in some occasions include a remarkable proportion of forest-dwelling taxa. The beginning of the Vallesian stage, defined by the first occurrence of the hipparionin equids at 11.1 Ma, did not represent any other noticeable change in the mammal faunas, with the persistence of virtually all the taxa known from the late Aragonian. This would suggest that the dispersal of these equids into the area would not be associated to significant climatic perturbations. In the course of the early Vallesian the mammalian faunas were even enriched by the entry of new immigrants of eastern origin, including some ruminants, carnivorans and cricetid rodents. However, at the boundary between the early and late Vallesian (9.7 Ma), an apparently abrupt extinction event (known as the Vallesian Crisis) occurred. It implied the disappearance of most of the taxa of Middle Miocene origin that were presumably adapted to humid forest environments. The Vallesian Crisis was first recognized at the Vallès-Penedès Basin and later extended to other European regions, and it has even been suggested that it might have been a continent-wide event. However, we show that, in the case of the Vallès-Penedès Basin, this pattern is strongly affected by sampling bias. Once these sampling effects are taken into account, the Vallesian Crisis turns from an abrupt extinction event into a progressive faunal turnover that implied moderate and gradual extinction of species that probably continued into the Turolian. Furthermore, our carbon and oxygen stable isotope data for rodent molar enamel do not show any remarkable shift coinciding with the onset of the Vallesian Crisis, and suggest the persistence of relatively warm forest environments during the late Vallesian.

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A NEW AMPHISBAENIAN REPTILE FROM THE LATE MIDDLE EOCENE OF FRANCE

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Keywords: *Blanidae, lower jaw, Paleogene, Europe.*

The amphisbaenians or worm lizards represent a peculiar group of squamate reptiles, adapted to a burrowing lifestyle. A new genus of amphisbaenian reptile is described from the late Middle Eocene of France. This material from the locality of Le Bretou (Phosphorites du Quercy) is an almost completely preserved mandible. The dentary bears six teeth, with the anteriormost one the largest. The anterior teeth are blunt and enlarged ('amblyodont'), and their size and amblyodonty decrease posteriorly. The presence of well-developed amblyodont teeth indicates a durophagous diet. Durophagy has already been recognized in some amphisbaenids, and their high skull, short jaws and robust tooth morphology predispose them to this durophagous lifestyle. This material shows unambiguous morphological features tying this specimen to Blanidae. This new taxon represents the earliest secure record of blandid lizards in the fossil record, confirmed by phylogenetic analysis.

TERRESTRIAL CARNIVORE INTRAGUILD INTERACTIONS: EVIDENCES FROM THE EARLY PLEISTOCENE SITE OF PANTALLA (ITALY)

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Keywords: Carnivora, fossil mammals, paleoecology, Pantalla, Villafranchian.

Natural populations and community structure are regulated by direct (e.g., predation) and indirect (e.g., exploitative competition) interactions among species. One interesting factor affecting carnivore populations is interspecific killing by other carnivores. These intraguild interactions are common in nature although ecological and behavioral factors affecting them are poorly understood (Palomares and Caro, 1999). This issue is often neglected in paleontological studies concerning the structure of terrestrial paleocommunities. This is mostly due to the absence of empirical paleontological evidence of these interactions.

The fossil assemblage from Pantalla (Umbria, Central Italy) offers the opportunity to investigate this topic.

Paleontological excavations carried out at Pantalla in 1995 (Gentili et al., 1997) allowed recovering about a hundred terrestrial mammal fossils in excellent state of preservation, including eight Carnivora and three Artiodactyla almost complete crania, together with several mandibles. The faunal assemblage includes *Apodemus* cf. *A. dominans*, *Canis etruscus*, *Vulpes* sp., *Lynx issiodorensis valdarnensis*, *Acinonyx pardinensis*, *Lutra* sp., *Sus* cf. *S. strozii*, *Pseudodama nestii*, *Leptobos* aff. *L. furtivus*, *Equus* sp. and *Mammuthus* cf. *M. meridionalis*. The assemblage can be referred to the Olivola/Tasso Faunal Units (Late Villafranchian Mammal Age, middle part of the Early Pleistocene; Cherin et al., 2014).

The morphological analysis of the fossil material allowed recognizing some clear tooth marks on at least three carnivore crania (two belonging to *C. etruscus* and one to *L. issiodorensis*). Some other marks on two other *C. etruscus* crania are less evident and more difficult to interpret. Biometric considerations (i.e., distance between couple of marks and mark diameter) suggest that the bite belonged to the giant cheetah *A. pardinensis*. These inferences are supported by virtual simulations performed with 3D models of the skulls, which were obtained from CT scans.

The recent morphological and functional study of the exceptionally well preserved *A. pardinensis* skulls from Pantalla (Cherin et al., 2014) has shown that this large carnivore's predatory behavior was different from that of the living cheetah *A. jubatus*. The *A. pardinensis* craniodental anatomy and inferred morphology of the masticatory muscle system suggest that its killing strategy was similar to that of pantherine cats, and this interpretation is supported by the present bite-mark analysis.

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BIOLOGICAL INSIGHTS FROM THE OSTEOHISTOLOGY OF *ZHOUORNIS HANI*, A LARGE ENANTIORNITHINE FROM THE JEHOL GROUP OF NORTHEASTERN CHINA

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Keywords: osteohistology, bone histology, enantiornithine, Mesozoic birds.

Several osteohistological studies of Mesozoic birds have provided valuable information about their biology. Among these are several specimens of enantiornithines that were recovered from various parts of the world, and from different time periods, as well as representing different stages of postnatal growth. Among these are, two enantiornithines from the Late Cretaceous Lecho Formation of northwestern Argentina (Chinsamy et al., 1994), *Concornis lacustris* from the Early Cretaceous of Spain (Cambra-Moo et al., 2006), STM 29-8 from the Jehol Biota (O'Connor et al 2014), *Parvavis* from the Late Cretaceous of China (Wang et al in press), as well as *Gobipteryx minuta* (= *Nanantius valifanovi*) and *Gurilynia nessovi* (Chinsamy and Chiappe, in press). The only embryonic fossil bird studied histologically, is generally considered to be an indeterminate enantiornithine (sometimes referred to as embryos of the Mongolian Late Cretaceous *Gobipteryx minuta*) (Chinsamy and Elzanowski 2001). A brief histological description of *Zhouornis* was also provided when the specimen was first described (Zhang et al 2013). Here we provide a detailed assessment of the bone histology of *Zhouornis*, and the palaeobiological implications of its histology.

Thin sections of samples of the femur and humerus of *Zhouornis* (specimen number CNUVB-0903) were prepared using standard histological techniques (Chinsamy and Raath 1992). The slides were examined under normal and polarized light using a Nikon E 200 microscope. Microphotography was done using a Nikon photomicroscope camera.

The compacta of the femur mainly consisted of parallel-fibred bone tissue which is interrupted by a distinct line of arrested growth (LAG). Several simple blood vessels are evident in the compacta before the LAG, but thereafter growth appeared to resume at slower rate. A tide line is evident in the compacta, and below this a narrow inner circumferential layer (ICL) that suggests that medullary expansion had been completed. The humerus of the same individual was sampled more distally, and a LAG is visible in localized regions. The histological structure of the bone wall shows that secondary reconstruction and remodeling had occurred and had removed much of the bone formed during earlier stages of ontogeny (Enlow, 1962). Comparisons with previous enantiornithine birds, suggests that although *Zhouornis* had experienced at least one cycle of growth and that it had passed its most rapid phase of growth, it had not yet reached skeletal maturity. *Zhouornis* bone histology appears to be similar to that of STM 29-8 described by O'Connor et al (2014) from the Early Cretaceous Jehol Biota. Interestingly during the early stages of ontogeny both these enantiornithine specimens appear to have formed bone at a slower rate than that of the Gobi enantiornithines (Chinsamy and Elzanowski, 2001; Chinsamy and Chiappe, in press) which preserve fibro-lamellar bone with primary osteons during early stages of growth.

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NEW DATA FROM BACCINELLO V0 (GROSSETO, TUSCANY), THE OLDEST ASSEMBLAGE OF THE ENDEMIC TUSCO-SARDINIAN LATE MIOCENE VERTEBRATE FAUNA

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Keywords: *Baccinello-Cinigiano basin, Tusco-Sardinian mammal faunas, Baccinello V0 fauna.*

The Late Miocene continental successions of the Baccinello-Cinigiano basin (Grosseto, southern Tuscany) records at least four superimposed vertebrate bearing horizons bracketed in the time span 8.2 - 6.4 Ma (Benvenuti et al., 2001; Rook et al., 2011). It is one of the longest continuous vertebrate bearing continental succession in the Neogene Italian record. The Baccinello-Cinigiano basin is celebrated for recording vertebrate assemblages that yielded the youngest European Miocene hominoid, *Oreopithecus bambolii* (Casanovas Villar et al., 2011).

The Late Miocene (MN11 correlated) endemic vertebrate assemblage of Baccinello V0 is the oldest vertebrate fauna within the Baccinello-Cinigiano basin succession. The Baccinello faunal assemblages are known since 1960's (De Terra, 1954; Lorenz, 1968; Hürzeler & Engesser, 1976). The Baccinello V0 assemblage, a small mammal fauna, was discovered in the 1980's by researchers of the Basel Naturhistorisches Museum and the material partially described by Engesser (1989), who reported about the murid remains. According to the latter author the V0 fauna includes: *Huerzelerimys vireti*, *Anthracoglis marinoi*, *Paludotona* sp., *Chiroptera* indet., *Soricidae* indet., and *Tyrrhenotragus* sp.

Surveys along the Trasubbie river by the authors were performed in June and July 2013, aiming to acquire a better knowledge of the geology of the Baccinello-Cinigiano Basin and the vertebrate fossil record of the Late Miocene of southern Tuscany. The good exposure conditions allowed us to investigate in details the sedimentary succession outcropping along the small creek Fosso della Fittaia, to individuate the V0 fossiliferous level, and to proceed with sediment sampling for screen washing.

After wet sieving and screening, the sample yielded a number of fossil remains improving our documentation of the Baccinello V0 assemblage. In addition to the already recognized *Huerzelerimys vireti*, and *Anthracoglis marinoi*, a few dental remains permit identifying the occurrence of a giant dormouse (possibly Gliridae nov. gen. et nov. sp. from Baccinello V1 described by Engesser in 1983). Worth noting the occurrence in our sample of two mandibles of *Soricidae* indet., as well as of several elements of the Herpetofauna (*Anura* indet., *Lacertidae* indet., *Anguillidae* indet., *Serpentes* indet., *Testudinae* indet.).

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MONCUCCO TORINESE (PIEDMONT, NW ITALY): AN EXCEPTIONALLY RICH LATEST MIOCENE VERTEBRATE LOCALITY

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Keywords: Messinian, Italy, vertebrate paleobiodiversity.

Over the last five years, the Messinian vertebrate record from Italy has been enriched by two new sites, located in the Tertiary Piedmont Basin (TPB), Verduno (CN) and Moncucco Torinese (AT). Both localities have yielded abundant and varied vertebrate assemblages contributing substantially to an improved definition and understanding of the paleobiogeographic relationships between different European regions at the end of the Messinian. Central European Messinian fossil vertebrates, and mammals in particular, are quite rare. Until now, this lack of information rendered a gap in the comprehension of the effects of the Messinian Salinity Crisis (MSC) on the terrestrial vertebrate communities. The exceptionally rich locality of Moncucco Torinese (MCC) offers an opportunity to bridge the chasm.

The stratigraphic position of the vertebrate-bearing strata suggests that the fossil assemblages date back to the late post-evaporitic phase (p-ev2, 5.42-5.33 Ma) of the Messinian. Fishes include several families (Myctophidae, Bythitidae, Sciaenidae, Gobiidae, Moridae, Gadidae) testified by a variety of otoliths. Overall, these remains indicate that marine conditions were present in the paleo-Mediterranean basin during the last part of the Lago-Mare phase of the MSC, and that sedimentation took place in coastal paleobiotopes. The herpetofauna includes at least 20 identified taxa (*Albanerpeton* sp., *Chelotriton* sp., *Lissotriton* sp., *Bufo* s.l., *Rana* s.l., *Hyla* gr. *H. arborea*, *Latonina* sp., *Pelobates* sp., *Testudo* sp., *Mauremys* sp., *Crocodylia* indet., *Agamidae* indet., *Anguinae* indet., *Lacertidae* indet., *Amphisbaenia* indet., *Scolecophidia* indet., *Eryx* sp., *Colubrinae* indet., *Vipera* sp.). *Chelotriton* and *Scolecophidia* indet. are reported for the first time in Italy. Although the majority of the bird remains are fragmented and incomplete, they attest to the occurrence of at least 10 taxa. The most outstanding are small *Palaeortyx* and *Strigidae* specimens and few species of *Passeriformes* of different size. Aquatic birds and species anyhow related to wet environments are absent.

Ungulates include rhinocerotids, *Tapirus*, and at least five taxa of artiodactyls, among which a suid of the *Dicoryphochoerini* tribe, *Gazella*, *Euprox* and *Pliocervus*. Carnivorans are represented by a viverrid, a small mustelid of the tribe *Ictonychini*, *Felidae* indet., *Pristifelis*, and a primitive ursid (*Ursavus*?). Cercopithecoid remains indicate the occurrence of two different taxa, the colobine *Mesopithecus* and the papionin *Macaca* (see Alba et al., this volume). Small mammals are diverse and abundant. Insectivores include a neomyine shrew, a galericine of the genus *Parasorex*, and a talpid. Lagomorphs are present with the ochotonid *Prolagus sorbini* and scanty remains of a leporid. Rodents are the most diverse and abundant mammals and are represented by 14 taxa of five different families (*Castoridae*, *Cricetidae*, *Muridae*, *Gliridae* and *Sciuridae*). Among them *Apodemus gudrunae* indicates a late Turolian age for these assemblages. It is worth noting that MCC documents the earliest European occurrence of the genus *Sciurus*.

With more than 60 vertebrate taxa identified in its fossil assemblages, Moncucco Torinese can be regarded as a crucial locality for the study of the last Miocene vertebrate communities of Europe.

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**VERTEBRATES FROM THE UPPERMOST STRATIGRAPHIC
SEQUENCE OF THE PIETRAROJA PLATTENKALK
(EARLY CRETACEOUS, SOUTHERN ITALY)**

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Keywords: *vertebrates, stratigraphy, Pietraraja Plattenkalk, Early Cretaceous, Italy.*

The Early Cretaceous Plattenkalk of Pietraraja (Benevento, southern Italy) is known since the eighteenth century for its diverse and exquisitely preserved ichthyofauna; in the last decades the site became extremely famous after the finding of *Scipionyx samniticus* (first dinosaur from Italy and unique in the fossil record, exceptionally preserving internal organs). Given the highly conservative nature of this Fossil-Lagerstätte, in 2001 the Museo di Storia Naturale di Milano conducted new fieldwork under the aegis of the Soprintendenza Archeologica di Salerno, with the aim to investigate the fossil contents of the uppermost layers. The latter date back to the Lower Albian, and are less rich in terms of number of fossils compared to the classical fish-bearing strata. Nevertheless, after 10 days of excavation more than 600 specimens were collected from 200 square meters of extracted layers.

The fish assemblage exhibits a moderately high diversity. Both articulated skeletons and isolated bones have been collected, including remains of *Notagodus pentlandi*, *Ocleodus costae*, *Belonostomus* sp., an indeterminate phyllodontid albulid, and the otophysan *Clupavus* sp. The presence of this moderately diversified fish assemblage, together with sedimentological data, indicates the persistence of good conditions for marine life in shallow waters, up to the end of the Plattenkalk deposition.

The presence of arid emerged areas close to the depositional basin is confirmed also in the uppermost layers of the stratigraphic sequence, by the finding of several remains of rhynchocephalian reptiles. Among them is a specimen with an estimated length of one meter, that represents the largest lepidosauromorph known to date from the Pietraraja Fossil-Lagerstätte.

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NEW ARCHOSAUMORPH REMAINS FROM THE TRIASSIC OF FRIULI (NE ITALY): WORK IN PROGRESS

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Keywords: *Triassic, Protorosauria, Archosauriformes, Pterosauria, Friuli Venezia Giulia.*

Some important fossil amniotes have been described from the Triassic of Friuli region of NE Italy. They include the sauropterygians *Protenodontosaurus italicus* (see Pinna, 1990) and *Bobosaurus forojuliensis* (see Dalla Vecchia, 2006); the drepanosaurid *Megalancosaurus preonensis* (see Renesto, 2000) and the pterosaurs *Preondactylus buffarinii* and *Carniadactylus rosenfeldi* (see Dalla Vecchia, 1998, 2009).

Work is in progress on some new interesting archosauromorph specimens found during the last decade, which are mostly still under preparation because of budget limits. The upper Anisian (Illyrian) "Torbiditi d'Aupa" yielded several bones (mainly vertebrae and appendicular elements) of the bizarre protorosaurian *Tanystropheus* (the beast in the logo of the meeting) and scattered remains of a crurotarsal archosaur. *Tanystropheus* is known mainly from skeletons preserved flattened on slabs from the Grenzbitumenzone/Besano Formation (Anisian/Ladinian boundary) of Switzerland (Tessin) and Lombardy (Italy); the Friulian bone are scattered and isolated, but are preserved 3D, allowing observation of features that are concealed in flattened bones. A partial skeleton of a diminutive archosauriform (humerus is only 21 mm long), including skull bones, comes from the lowermost Carnian "formazione della Val Degano" of the Tolmezzo Alps. Beds at the boundary between this unit and the underlying Dolomia dello Sciliar/Schlern in the nearby Fusea site have yielded some isolated archosauriform teeth. The Predil Limestone (lower Carnian, Julian) of the Julian Alps near Tarvisio is famous for its palaeoichthyofauna (known in literature as "Raibl palaeoichthyofauna") since the XIX century. Work is in progress on the second tetrapod remain from this unit (the first was a short caudal segment described by Dalla Vecchia, 1994). It is a partial skeleton of a probably new protorosaurian species. Finally, a nearly complete but disarticulate skeleton of a basal pterosaur comes from the Norian (Alaunian 3-Sevatian) Dolomia di Forni Formation of the Carnic Pre-alps; it probably represents a new species. These specimens will furnish more information on the archosauromorph diversity in the Alpine Triassic.

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THE VALLEY OF LAKES (CENTRAL MONGOLIA), A HOT SPOT OF OLIGOCENE-MIOCENE MAMMAL EVOLUTION

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Keywords: mammals, stratigraphy, geochemistry, paleoenvironment.

Since 1995 the Taatsiin Gol and Taatsiin Tsagan Nuur region is subject of Mongolian-Austrian palaeontological projects, carried out by and international team of specialists, and was granted by the Austrian Science Fund (FWF-Projects: P-10505-GEO and P-23061-N19).

In a first step we developed a stratigraphic concept, based on ⁴⁰Ar / ³⁹Ar-datings of basalts I–III and correlations with lithological data. Within that programme, eight biozones were defined. Our present palaeontological studies focus on the evolution of mammals and on changes of mammal community structures during the Oligocene and Early Miocene. From forty-five sections and fossil sites of the study area, more than hundred vertebrate assemblages were collected by bed-by-bed sampling and screen washing. The main sections have been logged in great detail, and data on natural gamma radiation and magnetic susceptibility were measured in field. Magnetic properties of paleosols are strongly influenced by the production of fine-grained secondary ferrimagnetic minerals during pedogenesis. Thus, a relation of magnetic susceptibility with paleoclimate and especially with precipitation is evident. For a reliable interpretation of these data, the isotopic signatures of the pedogenic calcite in the calcretes and paleosols was evaluated ($\delta^{18}\text{O}$, $\delta^{13}\text{C}$) as especially the stable isotope values of oxygen in pedogenic calcite are valuable paleoenvironmental proxies and allow the reconstruction of soil moisture.

1. The mammal assemblages of the Early Oligocene (biozones A-B) comprise numerous larger plant eaters, representing up to five Ruminantia families, along with Creodonta, Canidae and Didymoconidae of variable body-sizes, with *Hyaenodon* div. spec. and *Nimravus mongoliensis* being largest. Small mammals developed a high diversity, represented by Lagomorpha, Insectivora and Rodentia.

2. With the onset of the Late Oligocene (biozones C-C1), all large bone/meat eaters disappeared along with most Ruminantia species, and the giant rhinos (Indricotheriidae). The small mammal diversity increased and reached its maximum.

3. At the Oligocene/Miocene transition the majority of Oligocene genera and species disappeared, and during the Early Miocene (biozone D) most of the Oligocene holdovers were replaced by modern Miocene genera and species.

4. The information derived from geochemical analysis of paleosol and caliche layers and the interpretation of shifts in stable isotope signatures ($\delta^{18}\text{O}$, $\delta^{13}\text{C}$) are expected to give important insights into the paleoenvironment and the paleoclimatic development of the study area. These are fundamental to correlate changes in mammal associations with potential climatic changes.

PHYLOGENETIC COMPARATIVE METHODS: ALREADY IN VERTEBRATE PALEONTOLOGY? AN EXAMPLE FROM ARMADILLO'S SKULLS.

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Keywords: *statistics, evolution, covariation, independent contrasts, Xenarthra.*

In 1985, the famous Felsenstein's paper about the problem of non-independence of biological data including more than one species made an inflexion point about how researchers addressed comparative studies. Since then, many different methods, usually called Phylogenetic Comparative Methods (PCM), have been developed to solve this problem. There are two main objectives when applying Phylogenetic Comparative Methods, i) to analyze the changes in an evolutionary context, and ii) to solve the statistical issue of non-independence. Depending on the procedure used to evaluate the data (statistical or not) this last point will make the application of PCM methods mandatory. No matter the discussion about the meaning of the estimated ancestors, type and rate of evolution of the studied trait and accuracy of the phylogeny, the true is that statistical methods assume that data points are independent, and traits in species related by a phylogeny may are not. Thus the first step in such cases is to check whether or not the traits in more related species are more likely to be similar than in distant ones (phylogenetic signal).

Armadillos are a group of American mammals belonging to the Order Xenarthra. The covariance between the skull and the lower jaw of 12 species of armadillos was analysed using geometric morphometrics methods. A Partial Least Squares analysis (PLS) was developed after the Procrustes superimposition of both databases. PLS was applied to both the raw data and the independent contrasts, in order to exemplify how results may change when the phylogeny is taken into account. Although the pattern of covariance is similar for the first PLS, at evolutionary level (using PICs) a second axis of covariance appeared, and the total amount of covariance was higher.

On the other hand, the correlation between the shape of the skull and the Index of Fossorial Activity (IFA, Vizcaíno *et al.* 1999) was analysed again both in raw data and Independent contrasts. IFA is related to the digger habits of armadillos, which in turn are related to their diet, thus could be expected that the shape of the skull and the fossorial abilities of each species correlate at some degree. When using PICs, the percent of explained variance is clearly higher. Despite the many problems of PCMs, their application cannot be ignored. These methodologies are widespread in ecological and evolutionary journals, but still are not usual in the paleontological community. We paleontologists should join the discussions about their use and applications, adding our knowledge on the evolutionary processes.

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A ZIPHODONT CROCODYLOMORPH FROM THE EARLY EOCENE OF VASTAN LIGNITE MINE (GUJARAT, INDIA)

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Keywords: *Dyrosauridae*, *Sebecosuchia*.

Since 2004, the early Eocene Vastan lignite mine (Cambay Shale Formation, Gujarat, Western India) has yielded a rich herpetofauna with frogs, snakes, and lizards (Rage et al., 2008; Folie et al., 2013; Rana et al., 2013). But it is only in January 2012 that the first crocodylomorph remains were retrieved all together in one very thin lens of a few meters width. This small collection includes 4 teeth, 3 fragmentary vertebrae, 1 fragmentary femur, and 2 metapodials.

All the teeth are characterized by being distinctly elongated and labiolingually compressed. When well preserved, the mesiodistal carinae bear distinct serrations of the enamel (the ziphodont condition). The largest crown available is estimated to be at least 30 mm tall. In labial or lingual view, the outline of the crown is rather symmetrical. On the other hand, the smallest tooth is asymmetrical being curved in labial view with a nearly straight distal margin and a convex mesial margin. The fragmentary vertebrae share a slightly amphicoelous condition of the centrum. The largest centrum is 32.9 mm long and the neurocentral suture not clearly visible. A modest but well visible hypapophysis is placed close to the anterior edge of the centrum of both these vertebrae. The fragmentary left femur is represented by a proximal portion 45.0 mm long, extending from the totally eroded epiphysis to slightly distally to the fourth trochanter. The largest diameter at the level of the trochanter is 11.6 mm.

The ziphodont crocodylomorph teeth reported from a few Paleogene localities of the Indian subcontinent have been referred to both Pristichampsinae and Sebecosuchidae (Sahni & Srivastava, 1976; Buffetaut, 1978; Sahni et al., 1978; Gupta & Kumar, 2013). However, the latter taxon is considered absent in the Tertiary of Asia and amphyplatian vertebrae found in association with ziphodont teeth have been referred to dyrosaurids (Buffetaut, 1978; Turner & Calvo, 2005). Although non-eusuchian crocodylomorphs are restricted to two groups in the Paleogene (*Dyrosauridae* and *Sebecosuchia*), our limited knowledge of their postcranial anatomy renders identification of fragmentary remains difficult. Different hypotheses for the identity of the crocodylomorph remains from Vastan are presented.

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PARADOLICHOPITHECUS, A LARGE TERRESTRIAL PLIOCENE CERCOPITHECINE FROM EUROPE: NEW REMAINS AND AN UPDATE

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Keywords: Cova Bonica, France, Moreda, Senèze, Spain.

Dolichopithecus arvernensis Depéret, 1929, was based on a large female cercopithecoid skull from Senèze, France. Depéret thought it was congeneric with *Dolichopithecus rusciniensis*, a terrestrial colobine he had described from Perpignan. In 1961, Necrasov et al. described a fragmentary face and mandible from Graunceanu, Romania, as *Paradolichopithecus geticus*, a "colobine" similar to that from Senèze. Delson (1971) reported a partial mandible from Cova Bonica, Spain, which he compared to the preceding specimens but did not name. Delson and Plopsor (1975) and Szalay and Delson (1979) reported numerous additional cranial and postcranial remains from Graunceanu, as *Paradolichopithecus arvernensis*, noting that the Cova Bonica specimens and isolated fossils from Vialette (France) and Malusteni (Romania) might be a smaller form of that genus. Aguirre and Soto (1974, 1978) reported a mandible from La Puebla de Valverde (Spain) similar to that from Cova Bonica. Moyà-Solà et al. (1992) mentioned *Paradolichopithecus* from Moreda-1 (Spain). Van der Geer and Sondaar (2002) reported mandibles and postcrania of *P. arvernensis* from Vatera-F on Lesbos Island (Greece). Delson et al. (2000 and several later abstracts) summarized research on these fossils, indicating that the craniofacial morphology was most similar to that of *Macaca*, while the postcrania indicated a high degree of terrestriality, comparable to that of *Mandrillus* and *Papio*. Recently, numerous additional specimens from Cova Bonica and Moreda have become available for study, including a well-preserved adult male mandible, crushed subadult cranium, isolated teeth and partial postcranial elements which appear to document an early, small variety of *Paradolichopithecus*. Following new field research at Senèze (Delson et al., 2006), Nomade et al. (2014) reported an argon-argon date of ca 2.17 Ma, much older than previously thought.

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DIETARY SPECIALIZATION AND EXTINCTION OF WESTERN EURASIAN HOMINOIDS: EVIDENCE FROM DENTAL MICROWEAR

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Keywords: Iberian Peninsula, Miocene hominoids, diet, evolution, paleoecology.

Diet plays a central adaptive role in mammalian evolution, and hence paleodietary inference is paramount for understanding the relationship between evolutionary and paleoenvironmental changes through time. Here we rely on the traces left by food on tooth enamel (dental microwear analysis) of several Miocene hominoids from Western Eurasia to investigate the role of dietary specialization in their diversification and extinction. New microwear results for five Iberian hominoids are analyzed together with previous data for other genera from Europe and Turkey (Ungar 1996; King et al. 1999), thus covering a great part of the Eurasian hominoid radiation (ca. 14 to 7 Ma). Our analyses indicate that a progressive dietary diversification occurred during hominoid evolution in Western Eurasia. The presumably ancestral scerocarpic condition of the early Middle Miocene *Griphopithecus* is only subsequently displayed by the Late Miocene *Ouranopithecus* and the late Middle Miocene *Pierolapithecus*, although the latter shows closer resemblances with extant arboreal hard-object feeders (suggesting arboreal foraging in more closed and forested environments than for the other taxa). Among the remaining analyzed apes, only the Late Miocene *Oreopithecus* fits well with extant taxa, by displaying a soft-frugivorous diet that would have nevertheless been quite versatile (including to some extent leaves and hard-object items alike). The remaining extinct hominoids analyzed lack clear extant dietary analogues, being intermediate between soft-frugivores and hard-object specialists, suggesting that the late Middle Miocene *Anoiapithecus* and *Dryopithecus* had already begun to adapt to softer-fruit diets. The latter trend apparently culminated in the Late Miocene species of *Hispanopithecus*, which apparently relied more strongly on soft-frugivory, but still consumed hard items to some significant extent (maybe as fallback foods). Despite a climatic trend towards increased seasonality and lower temperatures, competitive exclusion and environmental heterogeneity apparently favored a progressive fragmentation of dietary niches. In the Late Miocene, this diversification culminated in highly-specialized dietary and locomotor adaptations, which might have precluded the acquisition of strictly folivorous diets. Our analyses therefore support the view that the same dietary specializations that allowed hominoids from Western Eurasia to face progressive climatic deterioration were the main factor that, when more drastic paleoenvironmental changes took place, ultimately led to their extinction.

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A CASE OF EXTREME MANUS ELONGATION IN SAUROPODS FROM THE LATE CRETACEOUS OF “LO HUECO” (SPAIN)

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Keywords: metacarpus, Titanosauria, Late Cretaceous, “Lo Hueco”, Spain.

The manus of the titanosauriform sauropods shows a stressing evolutionary pattern, characterized by elongated and tubular disposed elements, which is highly related with the columnar morphology of their forelimbs. Basal titanosauriforms elongation of the metacarpals is also correlated with an elongation of the humerus relatively to the femur (Salgado et al., 1997). The metacarpal elongation, also present as a convergence in some basal eusauropods such as *Turiasaurus* or *Atlasaurus*, persists in some more derived titanosauriforms, including basal lithostrotians such as *Rapetosaurus* or *Malawisaurus*.

Herein, an isolated set of four metacarpals (I, II, III, and IV) from the same left manus is described, being the most complete sauropod manus recorded from the Iberoarmoric territory. The specimen was collected at the “Lo Hueco” site (Cuenca, Spain), dated as Campanian-Maastrichtian (Late Cretaceous). The metacarpals are markedly slender (maximum diameter in the center of the shaft / length in the metacarpal III= 12.06). Metacarpal III is the longest, as generally occurs in titanosauriforms (Upchurch et al., 2004), while the shorter – metacarpal I –, is only reduced to 80% of the length of the III. Metacarpals II, III, and IV have flat distal surfaces, probably associated with the loss of pedal phalanges as occurs in lithostrotians (Salgado et al., 1997). The proximal end of metacarpal I is not totally preserved, but seems to be transversely compressed as in other titanosauriforms (Apesteguía, 2005). The distal third of the diaphysis is slightly bowed – character usually referred to the presence of a short first phalanx and ungual –, and the distal articular surface does not extend onto the dorsal surface of the metacarpal – except for metacarpal I – and is undivided, features considered as synapomorphies of Titanosauriformes (D’Emic, 2012). Metacarpal III presents a proximal articular end with a triangular profile, as in most advanced titanosaurs (Apesteguía, 2005), but also present in basal titanosauriforms. When rearranged together, the manus present a tubular structure, with “U”-shaped profile in proximal view. Laterally and medially the metacarpals became significantly shorter compared with the metacarpal III.

The stratigraphic position, the faunal context, and the combination of characters allow considering this manus as belonging to indeterminate titanosauriform that probably corresponds to a titanosaur. However, it is considered that such delicate and slender metacarpals are unique for sauropods, even for basal titanosauriforms, and particularly for titanosaurs. These metacarpals are unusually slender even compared with those of the basal lithostrotian *Rapetosaurus*, and distinct from the more robust type present in saltasaurids (Apesteguía, 2005). This manus probably belongs to one of the still undescribed titanosaur taxa from “Lo Hueco” (Ortega et al., 2008), but at present it is not possible to relate it with any of them. So, its taxonomic assignment remains open pending of further analyses. The interpretation of the “Lo Hueco” titanosaurian faunas will allow understand the phylogenetic position of this extreme digitigrade sauropod.

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DIVERSIFICATION OF MAMMALS FROM THE MIOCENE OF SPAIN

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Keywords: *mammals, Miocene, Spain, macroevolution.*

The Neogene mammalian fossil record from Spain is exceptional among European records due to its density of site occurrences, temporal coverage and taxonomic resolution. These qualities motivated this study, in which we evaluated changes in diversification, taxonomic composition, and trophic structure of large mammals from Spain over the late Middle and Late Miocene (from 12.0 to 5.5 Ma). Analytical methods applied to this record for the first time include ordination of fossil localities to improve temporal resolution and estimation of confidence intervals on temporal ranges of species lineages. We evaluated the diversification patterns for large mammals (generally >1kg) at the species level and compared results on the MN timescale with temporal intervals of 0.5 myr. Use of the MN timescale obscures important periods of faunal change due to the unequal duration of temporal units and the long duration of some intervals.

Diversity metrics of origination, extinction, diversification and turnover indicate three time intervals of significant change separated by periods of relative stability. (1) From 12.0 to 10.5 Ma, elevated origination rates coupled with low extinction rates led to an increase in diversity. Immigrants and geographic-range shifts of species from higher to lower latitudes during an interval of global cooling contributed to these faunal changes. (2) From 9.5 to 7.5 Ma, significant rates of change occurred in all diversity metrics, as well as in taxonomic composition and trophic structure. The beginning of this interval roughly coincides with the episode known as the Vallesian Crisis but, in contrast to previous studies, our analysis indicates that the faunal change occurred over a prolonged period with sequential episodes of extinction and origination. Disappearances of genera and even entire families indicate substantial replacement within the fauna. In terms of trophic structure, herbivores of forest affinities (with frugivores and browsers) were replaced by herbivores of open woodlands (with grazers and mixed feeders). (3) From 6.5 to 5.5 Ma, high extinction rates led to significant negative diversification and high turnover rates. This period of change coincided with the Messinian Salinity Crisis, although marine dessication was apparently not the driver of faunal change. Rather, the high extinction rates at this time were a response to geographic isolation due to tectonic barriers and intensification of latitudinal climatic gradients and aridification that had been underway since 9.0 Ma.

The maturity of some mammalian Neogene records, such as the Spanish record of Miocene mammals, allows the application of refined approaches to the study of macroevolutionary patterns. Ideally, these methodologies should be implemented in the fossil record of other regions in order to construct more accurate and comparable rates of origination and extinction, and geographic-range shifts of mammals within and between continents.

MACAQUES AT THE MARGINS: THE BIOGEOGRAPHY AND EXTINCTION OF *MACACA SYLVANUS* IN EUROPE REDUX

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Keywords: Pliocene, Pleistocene, Ecological niche modelling, Barbary macaque, time budgets.

The genus *Macaca* (Primates: Cercopithecidae) originated in Africa, dispersed into Europe in the Late Miocene and resided there until the Late Pleistocene. Although considerable work has been undertaken on the palaeontology and taxonomy of *Macaca* in Europe, relatively little work has been done on its palaeobiology and biogeography. In 2008, at the meeting on European primates in Grosseto, we presented some preliminary research on these topics. In this contribution, we compare European fossil macaque Pliocene and Pleistocene range data to those of widespread modern macaques and present an updated time budget model for *Macaca* living at different latitudes. We also report on new ecological niche models exploring the potential geographic range of *Macaca sylvanus* in the Pleistocene, also examining whether *M. sylvanus* could feasibly survive in Europe during the Holocene.

Based on fossil finds, *M. sylvanus* reached its maximum geographic extent in the Middle Pleistocene, with a calculated range (including sites in the Caucasus) well in excess of 3 million km². When compared to modern macaque distributions, this is greater than the *M. fascicularis* range but substantially less than that of *M. mulatta*. The *M. sylvanus* specimens found at West Runton in Norfolk (53°N) during the Middle Pleistocene are among the most northerly euprimates ever discovered. Our simple time-budget model indicates that short winter day lengths would have imposed a significant constraint on activity at such relatively high latitudes, so macaque populations in Britain may have been at the limit of their ecological tolerance.

Two basic ecological niche models using climatic and topographic data for the Last Interglacial and the Last Glacial Maximum alongside Middle and Late Pleistocene fossil distributions indicate that much of Europe, including areas where they have not yet been found, such as north western France, may have been suitable habitat for macaques. The models also indicate that areas of southern Europe in the present day have a climate that could support macaque populations. However, *M. sylvanus* became extinct in the Late Pleistocene, possibly at a similar time as the straight-tusked elephant, *Palaeoloxodon antiquus*, and rhino, *Stephanorhinus hemitoechus*. Its extinction may be related to vegetation change or increased predation from *Homo*, although other factors (such as stochastic factors occurring as a result of small population sizes) cannot be ruled out. Notwithstanding the cause of extinction, the European macaque may be a previously overlooked member of the Late Pleistocene faunal turnover.

CHARACTERIZATION OF APPENDIX LOCOMOTION USING THE RADIAL MOMENT OF INERTIA; CASE STUDY OF PTEROSAUR FLIGHT

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Keywords: radial moment of inertia, biomechanics, flight, cantilever beams, pterosaur.

The moment of inertia (I) reflects the bending forces that a bone can endure and is based on the area (amount of material) and the square distance from the mass centre (centroid). It is usually measured as I_x (dorso-ventral bending resistance) and I_y (medio-lateral bending resistance).

The moment of inertia has been used previously to characterize locomotion (flapping frequency (Kirkpatrick, 1990) and manoeuvrability (Thollessen & Norberg 1991)) because it reflects the forces acting in a bone (considering it as a beam). But if there are more than 2 forces acting in a bone the moment of inertia will only provide information on two axis (I_x and I_y), eliminating the possibility of establishing important patterns in the type of locomotion.

The proposal is to use a new parameter Radial Moment of Inertia (**Ir_{ad}**) to obtain graphs, with shapes that can be compared between organisms. To achieve this, it is necessary to divide the thin section in even slices and calculate the moment (I) for each slice.

$$I_{rad} = A \cdot (y - \text{Min})^2$$

Where (A) is the section area, (y) is the maximum distance of material to the centroid and (Min) is the smaller (y) of the sections of each thin section. The ($y - \text{Min}$) is used to try to avoid the scale problems.

The slices that endure more stress will have a larger (I) and the slices with lower (I) would reflect a section of the bone morphology that doesn't endure a lot of stress. The purpose of this is to create a graph of (I) that will represent the stress around the bone, related with the strength that each slice endures from muscular activity.

A computational implementation of the **Ir_{ad}** is currently being developed. Here I present the results of the manual implementation of **Ir_{ad}** to compare the proximal thin sections of the humerus of 5 bird and 5 bat species against one pterosaur species (*Bennettazhia oregonensis*). The patterns provided by the **Ir_{ad}** analysis separated the two flight types in relation to the muscles involved in stroke action, the birds with spikes in one axis and bats with three different spikes. Pterosaur section **Ir_{ad}** was similar to the bird pattern with only one spike, suggesting that birds are indeed the better analogue for pterosaur flight, although further analysis is needed.

The manual **Ir_{ad}** test applied here have a very low resolution due the small number of segments of each slice (12), but if the number of segments increment with a computational program, the resolution can be high. This test do not create a reconstruction of the shape of the thin section, this test create a pattern of meaningful measurable properties of a beam that form a solid biomechanical basis for to establish locomotion type comparisons.

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EVOLUTION OF THE SAURISCHIAN DENTITION

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Keywords: *Saurischia, teeth, morphospace, evolutionary rates.*

Saurischian dinosaurs originated as carnivores, but several taxa evolved herbivorous and omnivorous diets. Through the Mesozoic, different feeding guilds came and went, defined by their jaws and teeth. In order to characterize how many times and when diets evolved in Saurischia, we used morphometric, disparity and evolutionary rates analyses on 100 taxa belonging to the main clades of Theropoda and Sauropodomorpha.

These methods are used to explore the diversity of form through time and between subclades, and they identify times when evolution was unusually fast or slow. The calculations are based on 30 tooth characters, including aspects of tooth shape, tooth count, presence or absence of a rhamphotheca, and shape of the jaws. The aim of this study is to quantify volumes of morphospace occupied by the different clades and the disparity in the tooth morphologies. In addition, the overlap of different morphospace clusters gives important information about convergent events through time or between taxa of the same age. With disparity analysis, the amount of diversity in tooth shape is quantified among genera and subclades through time and mass extinctions. Moreover, ranges of morphospace and overlapping of morphospace are key elements to quantify convergent events among clades. Evolutionary rates are calculated to determine how fast a clade evolved related to changes in dentition and dietary shifts, testing if a particular diet favoured radiation in a clade or if the radiation and diversification of taxa are not related with feeding innovations. Various evolutionary models (Brownian, Early Burst, Trend and Ornstein-Uhlenbeck) allow for the reconstruction of a realistic model of evolution.

While little correlation between body size and dietary shifts has been found in Theropoda and Sauropodomorpha (Zanno & Makovicky 2013; Clauss et al. 2013), further investigations are needed on a larger dataset and to test alternative hypotheses; this study tests correlations between dietary shifts, innovation in dentition and variation in body size in order to quantify a potential relationships.

The preliminary results suggest a more intricate scenario for the evolution of dentition and feeding guilds through the Mesozoic, with important evolutionary implications for the clade Saurischia.

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FIRST REMAINS OF EUPRIMATES FROM MASIA DE L'HEREUET (EARLY EOCENE, CATALONIA, SPAIN)

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Keywords: Iberian Peninsula, Àger sub-basin, Masia de l'Hereuet, Notharctidae, Cercamoniinae.

The first studies on Eocene primates from the Iberian Peninsula were made in the last century by Miquel Crusafont-Pairó, who discovered several localities containing primate remains, mainly in the Pyrenean basins (Crusafont-Pairó, 1967). The knowledge about Paleogene primates from the Iberian Peninsula has increased during the last decade, especially regarding the middle and late Eocene (Marigó et al., 2011, 2013; Minwer-Barakat et al., 2012, 2013, among others). However, despite the existence of several early Eocene vertebrate fossil sites (Marigó et al., 2014), primate remains of this age are scarce and have not yet been studied in detail.

Masia de L'Hereuet is an early Eocene site located in the Àger sub-basin (Southern Pyrenean Basin, Northeastern Spain), which has yielded remains of Perissodactyla, Artiodactyla, Rodentia, Marsupialia and Lipotyphla. A preliminary study of this faunal assemblage has allowed to assign this locality to the Neustrian (MP8+9, Badiola et al., 2009). Regarding Primates, only a plesiadapiform, *Arcius* sp., has been described from this locality to date (Marigó et al., 2012). Here we present the first data on new unpublished primate material from this site, which represents the first mention of Euprimates from this locality.

The study sample consists of several isolated teeth, among which two different forms can be distinguished. The first morphology, characterized by the lack of paraconid and the closed trigonid basin in the lower molars, resembles the cercamoniine genus *Agerinia*. The second one, characterized by a prominent paraconid and an open trigonid basin in the lower molars, recalls the morphology of other cercamoniines such as *Donrussellia* and *Cantius*. Further analysis is required in order to make a specific ascription of this material, which constitutes the oldest record of Euprimates from Spain.

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THE SIWALIKS OF THE INDIAN SUBCONTINENT AS A LONG NEOGENE RECORD FOR SOUTH ASIA

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Keywords: *Miocene, biostratigraphy, Siwalik, small mammals.*

There is synergism in long biostratigraphic records that have many fossil horizons: the fossil record of the whole is greater than the sum of each assemblage. The Siwaliks of the Indian subcontinent constitute such a record for Neogene time, and are the principle source of information on evolution of the terrestrial biota of the biogeographic region of South Asia. Siwalik molasse deposits and lateral equivalents occur throughout northern and western Pakistan, northern India, and part of Nepal, and are closely linked to depositional systems to the east in Myanmar and Thailand. Together, they comprise paleobiological data for the terrestrial realm for nearly all of Neogene time. There are fossil data throughout the last 23 million years, with a dense temporal scale of representation. There are many fossil horizons with good resolution; almost every 100,000 year interval has some data. It is important to underscore that data quality throughout the sequence is uneven: some 100,000 year intervals are rich but others have few fossils. The Siwaliks contain a record of the members of a subtropical fauna, and the species richness is accordingly high, especially in the Middle Miocene, declining thereafter. Small mammals include tupaiids and small primates, hedgehogs, squirrels, dormice, gundis, and diverse muroids (rhizomyines, nesomyines, cricetids, murids), and other groups such as late Miocene leporids. Affinity of large and small mammal species appears to be mainly with assemblages from areas to the east and west at the same latitude, but very few species have records outside South Asia. Biostratigraphic evaluation of successive faunas reveals significant endemism throughout the record, but the proportion of the fauna that is endemic varies against the proportion of species that appear to be immigrants. Also, an important component of successive assemblages is those residents that persist over long times. Changing proportions of immigrant, endemic, and long-time resident species may reflect the kinds of biotic and abiotic conditions tracked by Badgley et al. (2014), which affected Siwalik faunas throughout the Neogene.

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THE EVOLUTION OF CRANIAL DISPARITY IN PLESIOSAURIA

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Keywords: *Plesiosauria, geometric morphometrics, disparity, plesiosauromorph, pliosauromorph.*

Plesiosauria were a group of highly successful marine reptiles that were major components of Mesozoic ocean ecosystems. Before the contribution of recent research and modern techniques, the phylogenetic relationships within the clade were largely based on body plan, accordingly Plesiosauria was subdivided into two morphotypes based on the relative proportions of the skull to neck length, namely “plesiosauromorphs” and “pliosauromorphs”; the first incorporates long-necked and relatively small-headed taxa, whilst the second groups includes short-necked and large-headed forms. Despite these groups having lost their systematic significance, due to the presence of intermediate basal forms and morphological convergence within Plesiosauroidea and Pliosauridae, they still represent distinct ecomorphological groups. Evidence suggests these two morphotypes would occupy different feeding guilds and have contrasting prey preference, spanning from piscivory (e.g., in *Xenopsaria* and *Microcleidia*) to extreme macrophagy in the largest pliosaurids (e.g., in *Thalassophonea*).

This exercise, which is part of a larger study covering the evolution of cranio-mandibular morphology and functionality within Sauropterygia, focuses on the disparity of skull shapes in Plesiosauria. The degree of morphological convergence and divergence was assessed with multivariate analysis and geometric morphometrics, covering diversity, disparity, and size of the entire lineage, of phylogenetically significant sub-groups and the two major morphotypes. While our analyses do not show significant differences in cranial disparity among the phylogenetic sub-groups, it is interesting that “pliosauromorphs” display reduced disparity in skull shape in comparison to the long-necked “plesiosauromorphs”. In contrast, the “pliosauromorphs” have significantly larger skull sizes and a greater range of sizes across their evolutionary history. This perhaps underlines the importance of skull dimensions in “pliosauromorphs”, and hints that this might have allowed them to reach and retain the apex of trophic webs despite the lack of highly specialised macrophagous adaptation as displayed in other marine reptiles (e.g. *Thalattosuchia*). More work is needed to fully understand the feeding habits of Mesozoic marine reptiles, the compilation of large datasets and new studies will hopefully provide the base to explore such a fascinating subject.

METRIORHYNCHIDS OF THE OXFORD CLAY FORMATION

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Keywords: *Metriorhynchidae*, *Oxford Clay Formation*, *macrophagy*, *Geosaurinae*, *Metriorhynchinae*.

The Oxford Clay Formation of the UK (OCF) (ca. 165–157 million years ago) is one of the best sampled rock units, and where numerous iconic marine reptile fossil specimens have been discovered. Such an abundance allows an accurate base for the study of the Middle Jurassic shallow marine ecosystems. The co-existence of several radiating lineages (Plesiosauria, Ichthyosauria and Thalattosuchia) represents an intriguing research area which is currently under investigation. Despite recent research and discoveries that have increasingly elucidated the evolutionary relationships within each group, these studies have underlined the need of modern revisions and re-descriptions particularly within Thalattosuchia. Interestingly the OCF strata provide evidence of several sympatric metriorhynchid species (including: *Metriorhynchus superciliosus*, *Gracilineustes leedsi*, 'M.' *brachyrhynchus*, *Tyrannoneustes lythrodictikos* and an un-described *Dakosaurus*-like taxon).

Amongst these taxa, there is variation in: total body length, skull shape, mandibular symphysis length, tooth count, tooth shape, tooth size, presence/absence of tooth serrations, serration density, humeral shape, deltopectoral crest size and shape, ilium shape, ischium dorsal margin morphology and femoral proximal head morphology. It has been suggested that niche partitioning enabled high biodiversity and reduced inter-specific competition. Here we present an updated account of the OCF Metriorhynchidae; particular emphasis is given to new studies on putatively 'macrophagous' taxa (i.e. species with adaptations to feeding on large-bodied prey). This includes: *Tyrannoneustes lythrodictikos*, *Suchodus durobrivensis*, the 'Mr Leeds *Dakosaurus*-like' specimen and the 'Melksham Monster'. Each of these taxa had craniodental morphologies related to macrophagy (large body size, serrated and enlarged teeth, increased gape, reduced tooth counts, etc). As such the radiation of macrophagous metriorhynchids occurred earlier than previously supposed, being already diverse by the Middle Callovian. One interesting feature is that macrophagous metriorhynchids were rare in the OCF, with only nine specimens attributable to one of these four macrophagous taxa. Their rarity is especially marked when compared to the three more common OCF metriorhynchids: *Metriorhynchus superciliosus* (at least 60 specimens), *Gracilineustes leedsi* (at least 12 specimens) and 'M.' *brachyrhynchus* (10 specimens). At present the reason behind the rarity of macrophagous metriorhynchids is unclear, although it could be related to the presence of macrophagous pliosaurids in the OCF (e.g. *Simolestes* and *Liopleurodon*).

Understanding the biodiversity of the OCF is of particular importance, as it is the last well sampled formation before a major faunal shift in Metriorhynchidae. In the Late Jurassic Kimmeridge Clay Formation of the UK, there is a shift from a metriorhynchine-abundant ecosystem (in the OCF) to a geosaurine-abundant ecosystem where macrophagous taxa are diverse and well represented.

THE OLDEST BLIND SNAKE IS IN THE EARLY PALEOCENE OF EUROPE

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Keywords: *Scolecophidia*, *Typhlopidae*, MP1-5, Hainin, Belgium.

Scolecophidians or blind snakes are among the most primitive and smaller snakes in the world with an average of size of 10 cm. They are worm-like, fossorial, lucifugous and often colourless, eating ants, termites, and their larvae. Based on the revision of Vidal et al (2010) they are represented by 5 families mainly living in tropical areas and have had a long history on Gondwana. The only European representative of this group is *Typhlops vermicularis* that lives around the Mediterranean Basin.

Here we describe two isolated procoelous trunk vertebrae from the early Paleocene of Hainin (MP1-5, Belgium), a locality already known for the oldest amphisbaenian lizards (Folie et al 2013) and the earliest European scincoid lizards (Folie et al 2005). These vertebrae are clearly attributed to a scolecophian by the following characters (List, 1966): they are 1.5 mm long and 1 mm high and wide; the centrum is narrow and the hemal keel is absent; the orientation of the prezygapophyses processes that serve for muscle attachment strongly differs from the one of the prezygapophyseal facets; the neural arch is depressed and does not present a posterior medial notch nor a neural spine.

Fossil scolecophidians are identified based on their vertebrae but they are generally considered as not diagnostic at a familial, generic or specific level. However, some characters have recently been proposed to differentiate the family level on the basis of the shape and placement of the synapophyses, shape of the cotyle, size of the zygosphenes, and shape of the prezygapophyseal facets (Gelnaw & Mead, 2010). Based on these features, the Hainin vertebrae differ from those of Anomalepididae and Leptotyphlopidae, and resemble those of Typhlopidae by similar neural arch morphology and height, development and orientation of the paradiapophysis, and morphology of the neural canal, cotyle and condyle.

Record of fossil scolecophidians indicates their presence in North America, Europe, Africa and Australia. Before this study, the oldest representatives of this group were known from the late Paleocene of Adrar Mgorn (Ouarzazate Basin) in Morocco and from the earliest Eocene of Dormaal (Tienen Formation, MP7) in Belgium. The scolecophidian from Hainin resembles more the one from Dormaal than that from Adrar Mgorn by narrower centrum and neural arch. The width of the neural arch in *Typhlops* is similar to both Belgian scolecophidians, however, the centrum is even narrower. By these characters, the scolecophidian from Hainin could represent a basal Typhlopidae.

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A NEW *PLATYPTERYGIUS* ROSTRUM FROM THE LOWER CRETACEOUS OF LESSINI MTS (N ITALY)

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Keywords: *Ichthyosaur*, *Platypterygius*, *Lower Cretaceous*, *Lessini Mts.*, *Northern Italy*.

The genus *Platypterygius* has been recorded in Italy from the Northern Apennines, but since now no precise data about the age of the fossils were available (Sirotti & Papazzoni, 2002).

A new finding of an incomplete rostrum of *Platypterygius* from the vicinity of Tregnago (Verona, Italy), in the Lessini Mts., now hosted by the Museum of Camposilvano (Velo Veronese, Verona, Italy), allows for the first time to determine an age. The matrix preserved within the rostrum bears quite abundant planktonic foraminifera. The identification of *Biticinella breggiensis*, *Macroglobigerinelloides bentonensis*, *Muricohedbergella* cf. *delrioensis* and *M. simplex* allowed to determine the *Biticinella breggiensis* Zone, or medium-upper Albian.

The fossil is a fragment of jaw and mandible containing 20 teeth, most of them still in their anatomical position. The piece has a maximum length of 15.2 cm and a maximum height of 10.2 cm. By comparison with the rostral sections figured by Sollas (1916), the fossil appear to be the intermedium-distal part of the rostrum. The preserved bones include in the upper part the premaxillas, nasals and vomers. In the lower part, they're quite fragmented and include dentals and splenials. Bones are not perfectly symmetrical with respect to the longitudinal axis.

The left side is the best preserved one, with the left premaxilla and the left dental along its entire length and 17 teeth, whose striped parts are from 8.0 to 15.0 mm, crowns from 5.0 to 8.0 mm and root from 24.5 to 28.0 mm tall. The peculiar subrectangular shape of the root has been used as diagnostic character for the genus. On the right side, the premaxilla allows the nasal to emerge in the upper side and matrix contains three scattered teeth.

This rostral fragment is strikingly similar to the one found in Gombola (Modena, Italy) and described first by Pantanelli (1889) and more recently Sirotti & Papazzoni (2002). The two specimens have similar teeth, with same shape, features and comparable dimensions. Unfortunately the Gombola specimen bears no index fossils in its matrix, so it is impossible to compare its age with the Tregnago specimen.

From literature (Druckenmiller & Maxwell, 2010) we know that the ichthyosaurs *Maiaspondylus*, *Athabascasaurus* and *Platypterygius* are recorded from the Albian. Nevertheless, among these only *Platypterygius* has teeth with the morphology observed in the Tregnago specimen. Accordingly, we attribute this fossil to the genus *Platypterygius* with no further specification, because of the lack of species-diagnostic features. However, we point out the significance of this new finding as the first Italian Cretaceous ichthyosaur precisely dated.

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CROCODILAN REMAINS FROM LAKE CHAPALA, JALISCO, SW-MEXICO

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Keywords: *Crocodylia, Late Pleistocene, Lake Chapala, SW-Mexico.*

The collection of the Museo de Paleontología de Guadalajara (MPG) has the largest and best documented collection of Pleistocene material from the lake Chapala. Amongst the material there are numerous remains of crocodylians comprising four osteoderms one of them coming from an alligatorid, and a fragmented vertebra from the basal caudal region. The material also comprises a number of isolated teeth from a Late Pleistocene fossil site on the beach of Lake Chapala about 50 km south of Guadalajara, Jalisco. The teeth are extremely different in size and shape and thus may either derive from different ontogenetic stages, especially of juveniles or different tooth positions of adults. Most of the teeth are shed and thus come from crocodylians that lived in the lake or its close vicinity. Those, who bear roots, derive from carcasses. Evidently the crocodylians not only lived Lake Chapala during Late Pleistocene but also reproduced there.

According to the global distribution of extant crocodylians the annual temperature average in the Lake Chapala area must have been 21° C with minimum temperatures above 0° C Today the annual average temperature is 19.9°C (GHEN, 1. 594 months between 1934 and 1984).

The remains of crocodylians show the same preservation pattern as most of the Late Pleistocene remains found along the shoulders of Lake Chapala. The material is fragmented and intensively mineralised and of a dark brown to black colour.

From the erosion states of the crocodylian teeth three taphonomic scenarios are reconstructed:

1. not or slightly eroded: fast deposition at or in the lake (autochthonous).
2. partially eroded: short distance transportation from a fluvial system (allochthonous deposition), or erosion in oscillating water movement at the beach (autochthonous deposition).
3. strongly eroded: long transportation or multiple reworking; deposited sediments along the shore line by changes of the water level (allochthonous).

Most of the teeth, if not all, are referred to the genus *Crocodylus* because of the strongly serrated prominent carinae. The largest tooth suggests an animal with a total length of 6 to 7 m, which would be consistent with an adult modern *Crocodylus acutus*. This species inhabits large coastal water bodies in the Caribbean and also the west coast of Mexico to the north until Guadalajara. The alligatorid osteoderm likely comes from *Caiman*. *Caiman crocodylus* in Mexico is today restricted to the Yucatan peninsula. It appears more than likely that *Crocodylus acutus* was the alpha predator in Lake Chapala during the Late Pleistocene and that *Caiman* inhabited the small water bodies in the periphery of that lake, which nearly filled the entire southern part of the Altiplano.

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A LATE MAASTRICHTIAN AIRPORT AT SAN FRANCISCO, COAHUILA, MEXICO

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Keywords: *Aves, Pterosauria, trackway, Late Maastrichtian, NE-Mexico.*

During the Late Maastrichtian the desert around the hamlet of San Francisco between Monclova and Saltillo was covered by a system of slow flowing shallow rivers and oxbows leading to the deposition of siliclastic sediments. A single silt layer was discovered with ripple marks, mud cracks and patchy remnants of bacterial mats. Likely, this sediment was accumulated in warm and shallow waters full of microbial life. This intertidal mud plain was deposited in a coastal bay at the shore of the Coahuila platform. The fine silty sediments gave the potential for preservation of tracks of all kinds of tetrapods. In this case – with one exception – the visitors to this place were aerial. They used the water rich mud plains as a kind of an airport. This is suggested by the remnants of these visitors, which mostly comprise footprints and trackways of an exquisite preservation state. Some of the trackways even accumulate to trampling horizons.

Most trackways were produced by small birds with the smallest footprint being just 25 mm long. The standard tracks have a diameter of about 65 mm with stout toes (anisodactyl) and webbing at the base of the toes (semi-palmate). A second more rare type of avian trackways is a little more than half the size of the standard one is also anisodactyl but does not show any webbing (apalmate). There is also evidence for tridactyl apalmate avians. One tridactyl footprint shows full webbing (totipalmate). Much more rare are manus and pes prints of Pterosauria with a maximum estimated wingspan of about five metres. While the manus prints are un-diagnostic and doubtful, the pes prints show a metatarsal area which is about three times the length of the digital area. Such a pes metatarsus ratio is well documented for Brazilian azhdarchoid pterosaurs. In conclusion the San Francisco pterosaur was azhdarchid. One single footprint with a length of about 200 mm was produced by a theropod, likely a coelurosaur.

Tracksites that combine avian and pterosaurian tracks are exceedingly rare, but have previously been reported from the Wuerhe asphaltite, Early Cretaceous, Xinjiang, and the Lower Cretaceous of Emei County, Sichuan China. From the Maastrichtian no such site is known to date, and the San Francisco track site outcrops one meter below the K/P boundary and thus may represent the latest record of dinosaurs and pterosaurs of Mexico. The biodiversity of birds with at least four different ichnotaxa compared with the scarce, monotypic record of pterosaur tracks suggests a gradual and not a catastrophic substitution of pterosaurs by birds before the end of the Cretaceous. This substitution may have been caused by a global cooling that commenced in the Late Campanian and persisted throughout the Early Maastrichtian, which could have been critical for pterosaurs, but not for birds.

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THE DINOSAUR DELTA AT LAS AGUILAS, COAHUILA, MEXICO
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Keywords: *Dinosauria, Coahuila, NE- Mexico, Late Campanian, palaeobiodiversity.*

The vicinity of the hamlet Porvenir de Jalpa, Coahuila, NE Mexico, particularly the La Aguilas valley some 5 km to the northeast of this village, are exceedingly fossiliferous, not only with respect to invertebrates and plants but also vertebrates such as turtles, crocodiles, and namely dinosaurs, which are documented by trackways and bones. The sediments are siliciclastic and belong to the Upper Campanian Cerro del Pueblo Formation. Deposition formed part of a gigantic delta system known as Difunta Group that drained to the east into the ancient Gulf of Mexico and was influenced by repeated marine incursions. The dinosaur bones and traces are found in intercalating sediments of a deltaic system that drained into the ancient Gulf of Mexico and occur in at least three different layers. The dinosaur bones mostly occur in clusters suggesting that they derive from complete or partial carcasses. Until now it remains unclear if the animals drowned near the embedding place, or were washed in by flood events that carried masses of silty material. The number of dinosaurian bone clusters is impressive. In one section, which is only about 200 metres long and 30 metres wide, at least 15 clusters were located with bones partially weathered out of the sediment. The vast majority of dinosaur bones are assigned to hadrosauromorphs with a size range from one to twelve meters. Theropoda are represented by Tyrannosauridae, Ornithomimosauridae and Dromaeosauridae but are predominantly documented by trackways. To date only a few bones of a weathered out partial skeleton and a hand full of isolated long bone sections are securely identified as theropods. However, some hadrosaur bones, namely vertebrae from the site show bite marks of theropods. Some of the bones are settled the drilling bivalve *Gastrochaenolites* suggesting that these bones have been reworked and were exposed to open water for a reasonable amount of time. Not only dinosaurs are found at Las Aguilas but also remnants of dyrosaurid and pholidosaurid crocodylians, mosasaurs, multituberculate mammals, trionychid and adocid turtles, sharks and sphenodiscid ammonites suggesting a rapidly oscillating palaeoenvironments of marine, barckish and limnic habitats. The land plants comprise mostly of Zingiberales and Areaceae representing a potential food source for the megaherbivores. The palaeobiodiversity of the Dinosaur Delta at Las Aguilas will allow us to reconstruct an unknown Late Mesozoic ecosystem on the southernmost margin of the North American continent, which probably was paleogeographically separated from the mainland in the north because of the lack of *Deinosuchus riograndensis*.

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UPDATING THE VALLESIAN GLIRIDAE (RODENTIA) RECORD FROM THE VALLÈS-PENEDÈS BASIN (CATALONIA, SPAIN)

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Keywords: Gliridae, Vallès-Penedès Basin, Vallesian, Miocene, Iberian Peninsula.

The Vallès-Penedès Basin (Catalonia, Spain) is a classical and renowned area for mammalian paleontology. It contains the type section of the Vallesian stage (early Late Miocene), an interval of important changes in the European mammal faunas, like the so-called 'Vallesian Crisis'. This event was first described at the early/late Vallesian boundary from the Vallès-Penedès Basin as a consequence of the observed extinction of most of the taxa theoretically associated with humid/forested environments (Agustí & Moyà-Solà, 1990). Among the rodents, the representatives of the family Gliridae, commonly known as dormice, were particularly affected resulting in the disappearance of several taxa characteristic of the late Aragonian (late Middle Miocene) and the early Vallesian.

During the last decade, a high number of new localities have been discovered and new fossils have been collected, allowing the improvement of the biostratigraphic and magnetostratigraphic information on the Vallès-Penedès Basin. Thus, the rich fossil record from this basin and its excellent age control has provided the framework necessary to reconstruct in detail the diversity and structure evolution of micromammal faunas within its paleoecological and paleoclimatic background, especially from the late Middle Miocene and the early Late Miocene. However, this kind of analysis of the fossil record requires the systematic and taxonomical reviews of different groups due to the new available material and information.

A current revision of Gliridae faunas from this basin, including new localities and new material from classical localities, indicates a decline in the diversity and relative abundance during the Vallesian but it appears to be less dramatic than previously assumed. Many of the taxa that seemed to have become extinct at the early/late Vallesian boundary are recorded in some late Vallesian localities (e.g. *Bransatoglis*, *Myoglis*, *Glirulus*, *Paraglrulus* and some species of *Muscardinus*). In general, the Gliridae are relatively rare during the Vallesian, showing a discontinuous distribution and being recorded only in localities with a large sample size. In addition, the sample size of early Vallesian assemblages is, on the average, larger than those from the late Vallesian. As a consequence, higher number of rare taxa can be recorded in the early Vallesian localities, and their absence in the late Vallesian could be due to sampling bias. This is confirmed by recent analysis of the diversity trends of the micromammal assemblages from the Vallès-Penedès, which concludes that the magnitude of the 'Vallesian Crisis' has been strongly influenced by the uneven quality of the fossil record (Casanovas-Vilar et al., 2014). This holds particularly true in the case of Gliridae.

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SKELETAL AND DENTAL GROWTH UNDER DOMESTICATION: THE CASE OF DOGS AND ITS RELATION TO CARNIVORAN EVOLUTION AND PALAEOLOGICAL STUDIES

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Keywords: *domestic dogs, island evolution, postnatal growth, heterochrony, life history.*

Domestic dogs – descendants of the grey wolf (*Canis lupus*) – are the oldest domesticated animals and their tremendous morphological variability makes them a unique system to investigate intraspecific variation, directed selection, and rapid evolution. Numerous morphological peculiarities of domesticated species can also be found in mammals which have evolved on islands, including dwarfism, shortened limbs and muzzles. Insights into morphological diversification arising through domestication can thus help to understand the evolution of extinct island mammals. Here, we examine postnatal ontogeny in aspects of growth and life history that can be traced in fossils. Not much is known about the variation and heterochronic shifts related to these markers of growth in different dog breeds and the wolf. We investigated cranial suture closure, epiphyseal growth plate closure, and dental eruption in ontogenetic series of wolves and different dog breeds representing various limb and skull morphologies. Data for 428 domestic dog and wolf individuals were collected based on X-rays and examination of macerated bones in different museum collections and veterinary facilities. These findings were integrated and analysed in the context of life-history data. We found that body size as well as relative limb size in domestic dogs can have an influence on the timing of the closure of the growth plates in the postcranial skeleton. Differing skull morphologies in different dog breeds are related to the timing of suture closure in the skull but not to the timing of tooth eruption. Life history variables were found to be mostly not different. These results indicate that the here investigated fundamental markers of growth, as well as life history variables, do not necessarily covary with variable adult morphologies. We expect that island forms, which exhibit adult anatomy that is significantly different from their mainland relatives, might not show any deviations regarding the postnatal growth and life history variables studied here. However, the great diversity in island forms and their ecological context prevents major generalisations.

NEW MATERIAL OF THE ENIGMATIC GIANT VIPERID *LAOPHIS CROTALOIDES* (SQUAMATA, SERPENTES) FROM THE PLIOCENE OF GREECE, WITH COMMENTS ON REPTILIAN GIGANTISM IN THE NEOGENE OF SOUTHEASTERN EUROPE

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Keywords : *Laophis*, *Viperidae*, *Neogene*, *gigantism*.

A fragmentary isolated vertebra from the early Pliocene of Megalo Emvolon (also known Karabournou) in Northern Greece is referred to the gigantic extinct viper *Laophis crotaloides* Owen. This taxon was originally named on the basis of 13 vertebrae recovered from Megalo Emvolon in 1857, and subsequently lodged in the collection of The Natural History Museum in London. Unfortunately, the type remains have since been lost and the species thus ignored or relegated to a *nomen dubium*, in spite of its estimated body length having potentially exceeded 3.5 metres. The incomplete and isolated nature of the new *Laophis* specimen hinders resolution to lower taxonomic levels. However, the fossil can be unequivocally placed within Viperidae because of its proportionally wide cotyle and condyle (the latter being markedly robust), probable presence of a hypapophysis, and most notably its dorsally tilted prezygapophyseal facets. Moreover, a multivariate quantitative approach supports previous assertions of large body size with an estimated maximum length and body mass, comparable to, if not larger than *Lachesis muta*, the largest extant viperid - a size that distinguish *Laophis* as amongst the largest extinct or extant venomous snakes ever known. The presence of a colossal viperid within the late Neogene ecosystems of mainland Greece is also significant because it concurs with the distribution of other gigantic Mio-Pliocene reptiles, including the large elapid *Naja* sp., another substantial but indeterminate species of *Vipera*, the varanid lizard *Varanus marathonensis*, and the colossal tortoises *Cheirogaster*. Similar coeval taxa have been found throughout the Balkan peninsula, southwestern Europe, and Asia Minor, and coincide with the onset of widespread climatic cooling during the late Miocene–late Pliocene. The spread of savannah grasslands throughout Mediterranean Europe during this time has been used to explain increased body sizes in herbivorous tortoises via dietary selection for greater consumption of C4 vegetation. However alternative ecological and/or physiological factors must be sought for large ectothermic predators, which would have had to effectively compete within a trophic system otherwise dominated by a broad range of mammalian carnivores.

A REVIEW OF *CUON ALPINUS* FROM THE EQUI CAVE (LATE PLEISTOCENE, APUANE ALPS)

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Keywords: *Canidae*, *Cuon alpinus*, *Equi cave*, *Late Pleistocene*, *Italy*.

The Equi Cave paleontological site is located in the northern side of the Apuane Alps Regional Park (Massa-Carrara, Tuscany). The palaeontological site is located on 257 m amsl, in the left side of the Fagli creek, and it returned thousand of different fossils remains, over than lithic industries and artefacts. The mammal assemblage is generally referred on biochronologic basis, to the central part of MIS 3, and recent radiometric datings from the lower levels in the Cave gave consistent chronology (Bigagli et al. 2013; Ghezzo et al. 2014).

The excavations at the Equi site began in 1909 and the study of the site went under the direction of Carlo De Stefani, from the Florence “Regio Istituto di Studi Superiori”, with regular annual campaign from 1911 until 1917 (De Stefani, 1917). De Stefani excavations allowed recovery of thousand of fossil specimens, determined in an early paper by Regalia (1911) and later by Del Campana (1923, 1954).

The Equi collection is nowadays kept in the Geology and Palaeontology section, Museum of Natural History of the University of Florence. The revision of the carnivore material allowed us identifying more fossil remains attributable to *Cuon alpinus* than what is reported in literature (Del Campana 1954; Petrucci et al. 2012).

Ethology of extant dohles allows us inferring about behaviour in fossil form, with special regard to the occurrence of other large carnivores in the same deposit, such as *Panthera leo spelaea* and *Panthera pardus*, probably based on mutual segregation and related to the environment and the prey availability.

The revision of the canid material from Equi, with the identification of additional dhole materials within the historical collection demonstrates that the rarity of this taxon in the European fossil record could be an artefact due to the lack of proper determination. It is much possible that a number of *Cuon* remains (especially parts of the post-cranial skeleton), are kept in museum collection identified as *Canidae* or *Canis* sp. (or even unidentified). A proper revision of Italian fossil mid-sized *Canidae* remains would be mandatory for a better picture of the dhole occurrence in the Italian (and European) fossil record.

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THE FOSSIL AVIFAUNA FROM THE LATE MIDDLE MIOCENE LOCALITY GRATKORN, AUSTRIA

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Keywords: birds, Sarmatian, Miogallus, Palaeocryptonyx, Necornis.

A rich vertebrate fauna was excavated during the last decade at the locality Gratkorn in south-eastern Austria, (federal state of Styria). The locality yielded one of the richest vertebrate faunas of the late Middle Miocene (~12.2-12.0 Ma) of Central Europe (Gross et al. 2011, 2014), dominated by fossils of mammals, reptiles and subordinate amphibians; fossils of fishes and birds are only sparsely represented.

The fossil avifauna from Gratkorn is documented only by isolated elements – 13 bones and two claws – most of them fragmentary, which hampers systematic determinations. However, at least three taxa of galliforms (Phasianidae) and a mousebird (Coliidae) could be identified.

Miogallus altus is the largest phasianid in the Miocene of Europe and is closest related to peafowl (*Pavo cristatus*) (Ballmann 1976); a middle sized quail represents cf. *Palaeocryptonyx edwardsi*; remains of a small sized quail are identifiable only on generic level as cf. *Palaeocryptonyx* sp.; another small-sized galliform bone fragment seems not to belong to the small-sized cf. *Palaeocryptonyx* sp., but might represent a fourth taxon.

Noteworthy is the presence of mousebirds, which are only very rarely proven in the Miocene of Europe, and which are restricted today to the African continent south to the Sahara. The fossils from Gratkorn were identified here as *Necornis* cf. *palustris*.

Due to the fragmentary preservation of all bird remains from Gratkorn most of the systematic affiliation determinations have to be made under reserve (cf.). Some more bird fossils were too fragmentary to be systematically determined.

All identifiable taxa are typical terrestrial birds; there is no evidence of any aquatic bird taxon in the fossil record of Gratkorn so far. Also no remains of birds of prey (especially owls) are detected to date, which are stressed (Prieto et al. (2010a, 2014), Gross et al. (2011)) to explain the extreme local concentration of small vertebrate fossils found in Gratkorn as the result of pellet accumulations at feeding/resting places.

All of these fossil bird taxa are described for the first time in Austrian deposits (Göhlich & Gross 2014).

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FOSSIL RECORD AND DYNAMICS OF THE LATE MIOCENE MAMMAL FAUNAS OF THE VIENNA BASIN, AUSTRIA

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Keywords: *Pannonian, Lake Pannon, mammals.*

The large and small mammal faunas of about 15 Austrian localities from the Vienna Basin, ranging from the late Sarmatian throughout the Pannonian, are considered in a current faunal analysis. Several of these faunas, especially the small mammal faunas, have been studied in detail only recently (e.g. Daxner-Höck & Höck in press, Daxner-Höck & Göhlich 2009, Harzhauser et al. 2011).

The Pannonian (Late Miocene) is a crucial time in the development of the Vienna Basin, which forms the northwestern edge of the Pannonian Basin. After the disintegration of the Eurasian Paratethys Sea, the Lake Pannon separated and formed in the Pannonian Basin at 11.6 Ma due to a glacio-eustatic sea-level drop (Harzhauser et al. 2008). From this moment on the Pannonian sedimentation in the Vienna Basin, which is made up by an up to 1200 m thick siliciclastic succession comprising lacustrine and terrestrial-fluviatile deposits (Harzhauser et al. 2004), was tightly connected to the development of the Lake Pannon.

Lake Pannon had its maximum expansion at 10.5–10.0 Ma in the Middle Pannonian (MN9) but subsequently retreated from the Vienna Basin during the Late Pannonian (Harzhauser et al. 2008). These environmental changes make the Pannonian an interesting stage for the evaluation and interpretation of the vertebrate fauna in the Vienna Basin. The current faunal analysis concentrates on the large and small mammal faunas, spanning from the late Astaracian to the early Turolian.

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REMORAS (TELEOSTEI, ECHENEIDAE) FROM THE OLIGOCENE OF THE WESTERN CARPATHIANS (CZECH REPUBLIC)

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Remoras (Percomorpha, Echeneidae), or suckerfish are characterized by a unique sucking disc on the top of the head. Its slat-like structures open and close to create suction and take a firm hold upon the skin of larger marine animals.

Fossil records of remoras are sparse and they were known to date from only the Tertiary sediments of the Tethys (Glarus, Switzerland), Paratethys (Carpathians, Caucasus) and Rhine Graben (Germany). The earliest record comes from the Glarus locality in Switzerland where Wettstein (1886) described *Echeneis glaronensis* as a new Oligocene species. This fossil representative was later assigned to the genus *Opisthomyzon* Cope, 1889.

The second interesting historical record comes from the Oligocene Menilitic Formation of the Polish part of the Carpathians, where Szajnocha (1926) described an echeneid cephalic disc and established the new species *Echeneis carpathica*. New echeneid material assigned to this species was recorded from a further eight Polish localities. (Jerzmanska & Swidnicka, 2003). Daniltshenko (1958) described *Echeneis urupensis* from the Miocene of the North Caucasus. From the Lower Miocene of the Hustopeče marl of the locality of Krumvíř (Czech Republic), Brzobohatý et al. (1974) published a partial skeleton of *Opisthomyzon* sp. From the Frauenweiler locality (Rupelian, Germany), Micklich (1998) assigned one complete specimen with sucking disk to the genus? Echeneis. From the Preliminary fossil records of remoras from the Šitbořice member of the Menilitic Formation (Moravian part of the Carpathians) were published by Gregorova (2009).

During an excavation supported by NGS at the Litence locality carried by the international team (Norbert Micklich, Alexander Bannikov, Sorin Baciu, Ionut Gadianu, Giorgio Carnevale) further important material was disclosed, in particular relating to the structure of the sucking disk. Detailed morphological and osteological analysis of fossil remains referred to as this Moravian representatives reveal that it may be distinguished from other members of the family Echeneidae by a unique combination of characters, including: 21–22 lamellae, 25-26 (10-11 + 15) vertebrae, dorsal and anal fins with 31–33 rays, caudal fin with 11–9+10–11 rays, pectoral fin with 19–21 rays which branch once, ending in two tips, emarginated caudal fin, neural spine on preural centrum 3 extends to between the anterior edge of the ural centrum and the hypurapophysis. Comparison of the morphological and osteological characters with the living representatives of the family reveal a number of differences that indicate a new fossil genus close to extant *Remora*.

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FOSSIL CROCODYLIAN PRESERVED IN POTENTIAL 'EGG-GUARDING' POSITION FROM THE MIDDLE EOCENE OF GEISELTAL, GERMANY: IMPLICATIONS FOR ARCHOSAUR PARENTAL CARE AND CLIMATE OF CENTRAL EUROPE

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Keywords: *Crocodylia, behavior, Diplocynodon, paratropical, ectothermic.*

Parental care is found in all living archosaurs (crocodylians and birds) and parsimony suggests this behavior is homologous (Tullberg et al., 2002), but while there have been known 'parent atop eggs' fossils of theropod dinosaurs (ancestors to birds; Grellet-Tinner et al., 2006), no equivalent fossil for crocodylians has been reported yet within this context. Partially as a result of this missing fossil record, arguments have been made that parental care may have evolved independently in crocodylian and bird lineages (Wesolowski, 2004).

Here is presented a remarkable fossil of a crocodylian parent (*Diplocynodon darwini*) preserved in a potential 'egg-guarding position' from the Middle Eocene of Geiseltal, Germany, providing for the first time evidence for the antiquity of parental care in the crocodylian lineage. The adult is preserved atop four well-preserved eggs that are consistent with the ovoid morphology of modern and fossil crocodylian eggs (Kohring & Hirsch, 1996). The size of the eggs relative to the crocodylian is consistent with known size relationships between mother and egg in living crocodylians (Verdade, 2001; Murray et al. 2013). Furthermore, an original site map from when the specimen was discovered indicates that no other egg-laying amniote was present nearby (Weigelt, 1933).

The preserved cervical vertebrae are partially broken along the unfused neurocentral sutures, demonstrating the key difference between sexual maturity and morphological maturity as defined by neurocentral suture closure (Brochu, 1996). Injury, flooding, volcanism, and desiccation are all unlikely causes of death as indicated by the preservation of the specimen and the geology of the site. The unusual curled posture of the adult, the position of the eggs, and the surrounding sediment indicate the adult died after oviposition, likely atop a shallow nest while attempting to maintain an even temperature for its young. The atypical posture has further consequences for the interpretation of the paratropical environment during the middle Eocene of Central Europe. Even in a paratropic environment, temperatures may temporarily drop below cold-tolerance for warm-adapted crocodylians (Grein et al. 2011), possibly explaining the death of adult and young. This fossil extends the record of crocodylian parental care back 45 million years, and indicates Central Europe's paratropical environment may have had infrequent short-term temperature drops that could be lethal for warm-adapted ectothermic vertebrates.

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THE MARINE VERTEBRATE FAUNA FROM THE LUTETIAN OF TAIBA NDIAYE (SENEGAL)

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Keywords: sirenians, cetaceans, Lutetian, phosphate, Senegal.

Although Africa seems to have played a pivotal role in the evolution of early placental mammals, the sub-saharian paleogene fossil record is very scarce and relatively little paleontological work has been carried out in this remote part of Africa. The great potential to discover early mammals in Senegal was demonstrated over half a century ago (Gorodiski & Lavocat 1953, Elouard 1966). However, unlike neighbouring Morocco, which has been intensely mined for phosphates and yielding one of the richest known paleogene vertebrate faunas of Africa, the phosphates of Senegal have remained largely unexplored for decades. Recent exploration of a Senegalese phosphate deposit revealed an untapped fossil resource. The primary aim of the PaleoSen project (www.paleosen.com) is to document the exceptional Eocene marine vertebrate faunas of Senegal by prospecting previously unexplored sedimentary basins. A preliminary fieldwork in the Eocene phosphate quarry of Taïba Ndiaye allowed discovering and describing the first African prorastomid remain ever unearthed (Hautier et al., 2012). Recently, the PaleoSen team discovered in the same deposits numerous yet undescribed fossil vertebrates, including partial articulated parts of skeletons. These successive discoveries have revived paleontological research in the Senegalese phosphate basins. The continued exploration of fossil bearing horizons in Senegal has the potential to greatly improve our knowledge on the origin and evolution of marine mammals and associated faunas. As recently highlighted with the discovery of sirenians, our discoveries will also provide pivotal data to examine the potential connections between African and New World faunas, as well as the role continental drift played in driving their evolution.

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THE DENTITION OF MEGALOSAURID THEROPODS, WITH A PROPOSED TERMINOLOGY ON THEROPOD TEETH

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Typically theropod teeth are described incomprehensively, yet these relatively abundant vertebrate fossil remains are not only constantly reported in the literature but also enclose extensive anatomical and taxonomical information. Often, important characters on the crown and ornamentation are omitted and in many instances authors do not include the description of theropod dentition altogether. The paucity of information makes identification of isolated teeth difficult, and taxonomic assignments uncertain. Therefore, we here propose a standardization of the anatomical and morphometric terms for each tooth anatomical sub-units, as well as a *modus operandi* on how to describe isolated teeth comprehensively.

This lack of information has been particularly striking in basal theropod clades, and ziphodont dinosaurs with superficially similar dentition. Therefore, we provide a detailed description of the dentition of Megalosauridae, and a comparison to and distinction from morphologically convergent teeth of all major theropod clades. Megalosaurid dinosaurs are characterized by a mesial carina facing mesiolabially in most mesial teeth, centrally positioned carinae on both most mesial and lateral crowns, a mesial carina terminating above the cervix, and short to well-developed interdenticular sulci between distal denticles. A discriminant analysis performed on a dataset of numerical data collected in the teeth of 62 theropod taxa reveals that megalosaurid teeth are hardly distinguishable from other theropod clades with ziphodont dentition. As a corollary, this study highlights the importance of detailing anatomical descriptions and providing additional morphometric data on teeth with the purpose of helping to identify isolated theropod teeth in the future.

APPLIED VERTEBRATE PALAEOLOGY

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Keywords: *extinction, catastrophism, environmentalism, evolution, Inatsisartut.*

The Sixth Extinction. An Unnatural History, by Elizabeth Kolbert (2014), was summarized as “man’s role in the current spasm of plant and animal loss” and reviewed by the prominent environmentalist, former Vice-President of the United States Al Gore (2014). As an experienced politician, and author as well as founder and chairman of projects addressing global change, Gore is a remarkable spokesman for Western conscientiousness. He outlined consequences of human-caused climate change, for example in “Viruses, bacteria, disease-carrying species like mosquitoes and ticks, and pest species like bark beetles are now being pushed far beyond their native ranges”. The observation of a vulnerable steady-state nature is that of a catastrophist.

Fossils through the stratigraphical column made Georges Cuvier (1769-1832) see marked alterations in the shape of organisms through time which he interpreted as due to extinctions caused by terrible events or catastrophes followed by immigration from undisturbed regions. Posterity acknowledges the core of Cuvier’s catastrophism paired with evolutionary theory. Some rocks contain evidence of revolutionary events in the form of geologically instantaneous, large-scale, natural processes that profoundly affected biodiversity, causing extinctions and creating opportunities for evolution. To civilizations, disturbance of the ‘normal’ environment can be disastrous, as it can to species. Environmentalists advocate protection and preservation of known, ‘pristine’ conditions. They may support evolutionary theory and ignore evolution.

Evolution is progressive interaction of Sun, Earth and organisms. Oxygen set free by early photosynthesizers was harmful to established species while constituting fresh challenges to life, as is carbon dioxide liberated by industrialized man. Five pre-Quaternary great mass extinctions have been identified from the rocks, with conjectured or unknown causes. The Recent great mass extinction is basically caused by man. Weather patterns are sensitive to consequences of human enterprise such as land clearing and heat emission from cities, and global climate is influenced by human as well as by planetary and astronomical factors. Yet species may survive changes in climate and sea level by moving to new areas, by modifying their dietary habits or by other ecological adaptations. Plate tectonic activity may cause regional or continental extinction and enhance evolution. But ultimate threats to the modern species and ecosystems are the activities of the globally operating, entrepreneurish humans who with increasing intensity disturb environments, over-exploit organisms, break up food-chains, deplete other species’ resources of food and water, pollute air, ground and seas with chemicals, waste and sound, *et cetera*. There are reasons to think we are fatally ruining the biosphere, with *Homo sapiens* integrated, leaving Earth to organic evolution from presently remote gene pools. Is that what we want?

Cultural patterns within human societies form barriers to the flow of ideas, and splitting of interests into separate fields of learning hinder vital comprehension. *Sommes-nous tous voués à disparaître?* by Buffetaut (2012) is a critical address to the public on man’s role in extinction. Legislation may regulate the human impact, as in the Faeroes with all c. 80 bird species subject to legal protection. A case of vertebrate palaeontology used in a petition for the protection of threatened birds addressed to Inatsisartut, the Greenland Parliament, will be looked into.

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SAUROPOD BODY FOSSILS IN EUROPE: OVERVIEW AND CURRENT ISSUES

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Keywords: *Sauropoda, Europe, paleogeography, Jurassic, Cretaceous.*

The very first sauropod taxa described in the world were the basal eusauropod *Cetiosaurus* and the tooth-based *Cardiodon*, from the Jurassic of England, UK. Since then new discoveries have led to a large European sauropod fossil record, including more basal forms from England (*Cetiosaurus*, *Cetiosauriscus*), France (*Bothriospondylus*), and diverse turiasaurs from Portugal and Spain. However, many uncertainties concerning the systematics of some specimens exist; partly due to little knowledge existing on early eusauropod evolution in the Jurassic, but also due to the fragmentary nature of many of these finds.

Recent revisions of *Cetiosaurus* from England, as well as material from France and Switzerland, provide a better understanding of the distribution and taxonomy of these sauropods, and could possibly exclude some taxa from Eusauropoda, aiding in finding more valid synapomorphies of the clade. With this information, other basal eusauropods (from outside of Europe) can be revised and the early evolution and radiation of sauropods from the Early Jurassic onwards may be better understood.

Concerning the fragmentary dental material known from basal sauropods, enamel wrinkling pattern proved to be useful to distinguish morphotypes in Argentinian eusauropods, and can probably serve as well as a tool to assess taxonomic diversity of European sauropods.

A more diverse European record exists of more derived sauropods, particularly from Spain and Portugal, but also from Germany, Romania, and France. This high diversity in the Late Jurassic and Cretaceous is probably due to the patchy distribution of islands and shallow sea during those periods, resulting in diverging evolutionary trends. Indeed, Europe provides unique evidence for island dwarfing in sauropods, which are *Europasaurus* from the Upper Jurassic of Germany and *Magyarosaurus* from the Upper Cretaceous of Romania. In contrast, some of the largest sauropods in the world are known from the Upper Jurassic and Lower Cretaceous of Spain and Portugal.

Recent revisions of Portuguese taxa show a rich diversity of neosauropods including diplodocids, camarasaurids and basal titanosauriforms. The sauropod fauna of the Lourinhã Formation is thus very similar to the contemporary Morrison and Tendaguru Formations in the USA and Tanzania, respectively. Early Cretaceous taxa are mainly known from Spain, whereas Late Cretaceous forms were found in a number of European countries.

In total, 25 genera and species are considered valid in Europe. Representatives from all major subgroups other than Dicraeosauridae are present, and taxa are known from the Early Jurassic (*Ohmdenosaurus*) to the Late Cretaceous (*Magyarosaurus*, *Ampelosaurus*), covering nearly the entire period of sauropod evolution.

BRAIN ENDOCAST ANALYSIS OF *MEGANTEREON CULTRIDENS*

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Keywords: paleoneurology, brain endocast, CT scanning, *Meganteron cultridens*.

The brain of vertebrates is probably is the organ with the highest degree of complexity. Brain controls many functions of coordination and control of physiological and metabolic activities of the body. It is also the fundamental processing center of all informations of the cognitive system. In Vertebrate Paleontology the analysis of the cranial cavities is the only opportunity to investigate this topic. There are specific methods to recreate the external anatomy of the brain and submit it to comparative and morpho-functional analyses. Well-preserved skulls can be scanned by CT scans and through medical imaging software it is possible to recreate the virtual casts of the brain cavity (endocast) (Iurino et al., 2013). The use of tomographic images in Palaeoneurology, allows to obtain more detailed and versatile virtual brain models, facilitating the advancement of the current anatomical, metabolic and ethological knowledge of saber-toothed felids. This type of research will not only help to better understand the dynamics of the encephalization process that has affected the mammals, but will help to shed light on some behavioral aspects still unclear of the Pleistocene carnivores.

A preliminary anatomical description of an exceptional preserved brain endocast of a sabertoothed felid *Megantereon cultridens* is here reported for the first time. The specimen considered is stored at the Museum of Palaeontology of Florence (catalogue number IGF831) and comes from the Early Pleistocene site of Terranuova Braccolini (Upper Valdarno) (Fabrini 1890; Ficarelli 1979; Sardella 1998).

The fossil skull was scanned at hospital Azienda Ospedaliero-Universitaria Careggi and a 3D model was prepared after a computer analysis carried on by Mimics 14.1. The brain sulci roughly delimit the so called "functional areas", ie those portions of the brain used for the control/coordination of the sense organs. The identification and comparison of these functional areas of the *Megantereon* brain with those of the large extant felids, has allowed the reconstruction of the sensory system of this large extinct felid.

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**EXCEPTIONAL SOFT TISSUE FOSSILIZATION OF A LATE
PLEISTOCENE VULTURE (*Gyps fulvus*) FROM ALBAN HILLS
VOLCANIC REGION (ITALY)**

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Keywords: *soft tissue fossilization, taphonomy, Gyps fulvus, Late Pleistocene.*

Volcanic sediments are often unsuitable for the fossilisation of both hard and soft organic tissues, however, in some circumstances, they can provide unusual conditions for the preservation of remains. Fossil animal remains preserved within sediments of volcanic origin constituting only ~2% of known bonebeds of Phanerozoic age (Behrensmeyer, 2007).

Here we report an exceptional case of soft tissue fossilization of a Late Pleistocene Eurasian griffon vulture (*Gyps fulvus*) embedded in blocks of the PA ignimbrite, discovered in 1889 in the pyroclastic sequence of the Alban Hills volcanic region (SE Rome, Italy) (Meli, 1889,1892; Manni et al., 2003-2004). CT analyses have revealed an exceptional natural cast of the complete head and neck that preserve extraordinary detail including the fossilized everted tongue, beak, feather insertions and the first record of the nictitating membrane of the eye. This fossilization (superior in detail even to the victims of the AD 79 Plinian eruption of Vesuvius) reveals no evidence of burning and requires re-evaluation of the thermal constraints in operation for the preservation of organic materials within pyroclastic sediments. The analysis of the external morphological features has provided key information regarding the taphonomic processes in operation, the emplacement temperatures of distal pyroclastic flow deposits and the relationships between organic materials and low temperature phreatomagmatic flows.

This sheds light not only on the extremely rare situation of fossilization in volcanic contexts but also provides a new perspective on taphonomic studies of highly detailed casts of fossil vertebrates.

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PALEOGENE ANTARCTIC PENGUINS: THE CURRENT STATE OF KNOWLEDGE

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Keywords: Paleocene, Eocene, Antarctic Peninsula, Sphenisciformes, evolution.

Penguins (Aves: Sphenisciformes) are highly specialized seabirds native to the Southern Hemisphere. Their first occurrence in the fossil record dates to the Early/Middle Paleocene of New Zealand and is very limited. The earliest remains attributable to Antarctic penguins are Late Paleocene in age. They are represented by four identifiable bones and 28 bone fragments collected within the Late Paleocene Cross Valley Formation on Seymour Island (Antarctic Peninsula). This incomplete skeleton, the holotype of *Crossvallia unienwillia*, provides direct evidence of the Paleocene origin of the extremely large size in penguins. The most intriguing feature of *Crossvallia* appears to be the morphology of its femoral head, clearly different from that in other Sphenisciformes, both extinct and extant, and their closest living relatives. The vast majority of penguin remains from the Paleogene period come from the Eocene La Meseta Formation on Seymour Island. Thousands of specimens, mostly isolated bones, have been collected within numerous sampling localities representing most (if not all) ages of the above-mentioned epoch as well as a range of climates and environments. Fossil penguins are particularly abundant in the uppermost part of the La Meseta Formation, that is within strata deposited close to the Eocene/Oligocene boundary and the rapid expansion of continental glaciation. Ten widely accepted species of Sphenisciformes belonging to six genera are known from the formation, all of them are present in its youngest unit. There is a strong line of evidence suggesting that the actual taxonomic diversity was even more impressive. Individuals belonging to four species, *Anthropornis nordenskjoeldi*, *A. grandis*, *Palaeudyptes klekowskii* and *P. gunnari* ('giant' penguins), clearly exceeded, in terms of body size, extant emperor penguins (*Aptenodytes forsteri*). Recently, a probabilistic method has been developed to help in reasoning on the classification of tarsometatarsi (numerous and important, but often poorly preserved bones) attributable to *Palaeudyptes*. This genus includes two Antarctic species of penguins with partly overlapping size distributions. Representatives of remaining taxa, *Archaeospheniscus wimani*, *Delphinornis arctowskii*, *D. gracilis*, *D. larseni*, *Marambiornis exilis* and *Mesetaornis polaris*, were either medium- (modern *Eudyptes/Pygoscelis*-like) or large-sized (modern *Aptenodytes*-like) penguins. Interestingly, whereas some large and 'giant' penguins are Paleocene in age (specimens from New Zealand and Antarctica, respectively), the earliest bone attributable to the medium-sized sphenisciform comes from the Early Eocene of the La Meseta Formation. Living aside the body-size issues, the Eocene Antarctic penguins also differed in other respects from their present-day counterparts. For example, some of them had elongate tarsometatarsi and/or dagger-like beaks, to name just two features. Nevertheless, they were obviously highly adapted to the marine environment, as suggested, among others, by wing morphology (flat bones) and a relatively weakly developed lumbosacral 'sense organ' involved in the control of walking. The Oligocene penguins are known solely from lower latitudes.

THE LONG-NECKED *TANYSTROPHEUS*: A BONE HISTOLOGICAL ANALYSIS

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Keywords: *Protorosauria, vertebra, histology, microstructure.*

Throughout evolution, several vertebrate groups independently developed a tendency to elongate the neck. Most prominently, the sauropod dinosaurs possessed the longest absolute necks, up to 15 meters in length (e.g., Klein et al., 2012). But neck elongation can also be found in several fossil marine reptile species, such as in plesiosaurs with their impressive number of cervical vertebrae, and among extant groups in giraffes and several bird species (e.g. swan, ostrich). A peculiar protosaur, the “giraffe-necked reptile” *Tanystropheus* (Protorosauria, Archosauromorpha; see for example Wild, 1973, Tschanz, 1986) took the elongation to the extreme.

Tanystropheus lived in the Tethys Ocean from the Middle to Upper Triassic (approximately 242 to 210 Ma) and it possessed a neck that made up over half of the total body length. Adult *Tanystropheus* could reach up to 6m in length, but the elongated neck consists of merely 13, extremely elongated vertebrae. Another protosaur, *Dinocephalosaurus* from the Triassic of China (Rieppel et al., 2008), had a similarly elongated neck but with over 27 cervical vertebrae. A neck structure as is found in *Tanystropheus* thus calls for unique anatomical adaptations. One visible trait in both long-necked protosaurs are the hyper-elongated cervical ribs that overlap several intervertebral joints. Soft tissues, like connective and muscle tissue, must also have been involved into the bracing of the vertebral column of the neck. However extant equivalents are lacking to compare the functional aspects with, and based on the osteology alone, several neck postures have been postulated for *Tanystropheus*, from a question mark like curvature to a straight horizontal posture (e.g., Tschanz, 1986). Details of the lifestyle of these animals are equally uncertain. In this study we present a bone histological analysis of axial and long bones of *Tanystropheus* with the aim to provide additional information which helps us understand the nature of such an extreme adaptation as the extremely elongated neck. All sections show a lamellar-zonal compact bone structure, relatively isometric in long bones. In vertebrae, the centrum grew faster than the spinous process, which is subject to extensive remodelling. The primary bone nature of the cervical ribs support the hypothesis of a stiff, horizontal neck posture.

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RE-DESCRIPTION OF ‘*STENEOSAURUS*’ *OBTUSIDENS*, A LARGE-BODIED CROCODYLOMORPH FROM THE MIDDLE JURASSIC OF ENGLAND (THALATTOSUCHIA; TELEOSAURIDAE)

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Keywords: *Thalattosuchia*, *Teleosauridae*, *Steneosaurus*, *Steneosaurus obtusidens*.

Teleosauridae was a group of longirostrine semi-marine Jurassic crocodyliforms superficially resembling extant gharials. Along with Metriorhynchidae, they constitute the larger clade Thalattosuchia. Multiple specimens have been collected from the Peterborough Member of the Oxford Clay Formation (OCF) of the Peterborough Member in the United Kingdom. All teleosaurids from the OCF have been attributed to the genus ‘*Steneosaurus*’; however, recent phylogenetic work has demonstrated that ‘*Steneosaurus*’ is paraphyletic and therefore needs to be revised (Young *et al.* 2012). One particular species from the OCF, ‘*Steneosaurus obtusidens*’, is thought to be closely related to the Late Jurassic *Machimosaurus* (Hua *et al.* 1994; Martin and Vincent 2013). ‘*S.*’ *obtusidens* was originally named and described by Andrews (1909; 1913). Since then, little work has been done on the material of this animal, aside from scanning electron microscopy on their teeth (Young *et al.* in press).

Here we report our findings on the re-description of the holotype of ‘*Steneosaurus obtusidens*’ (NHMUK PV R3168). We also compared it to two other specimens (NHMUK PV R3169 and NHMUK PV R3898) referred to be Andrews as this taxon. The holotype, represented by a nearly complete skeleton, has 14 apomorphic characters including 3 sacral vertebrae, large anteromedial supratemporal fossae, no axis diapophyses, and serrated teeth. ‘*S.*’ *obtusidens* displays a unique mixture of teleosaurid and metriorhynchid features, questioning the position and validity of the species. Andrews’ referred specimens (NHMUK PV 3169 and NHMUK PV R3898) more closely resemble *Steneosaurus durobrivensis* than *S. obtusidens*. As such, the only specimen currently referable to ‘*S.*’ *obtusidens* is the holotype.

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**STENEOSAURUS DUROBRIVENSIS (THALATTOSUCHIA;
TELEOSAURIDAE): THE LARGEST KNOWN TELEOSAURID FROM
THE OXFORD CLAY FORMATION OF ENGLAND**

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Keywords: *Thalattosuchia*, *Steneosaurus durobrivensis*, *Teleosauridae*, *Steneosaurus obtusidens*.

Teleosauridae was a group of gharial-like crocodyliforms from the Early to Late Middle Jurassic (Young *et al.* in press a). Along with Metriorhynchidae, they constitute the larger clade Thalattosuchia. They display a number of distinguishing characteristics, the most distinguishing being an elongated rostrum with a transversely expanded premaxilla. Teleosaurids represent the first clade of crocodylomorphs to reach large body size, with some individuals being over 5m in total length.

Here we report the re-description of the teleosaurid specimen NHMUK PV R3898. It was discovered in the Oxford Clay Formation (Callovian, Middle Jurassic) of Peterborough, England. The specimen consists of one femur, one ischium, and one ilium. All three bones are massive in size, robust, and heavy in weight. Although the specimen was attributed to '*Steneosaurus obtusidens*' by Andrews (1913) due to its massive size, the bones match the morphological features of *Steneosaurus durobrivensis*. These include: longer ilium anterior process, a more strongly sigmoidal femur, and heavy acetabulum ridge on the ilium. The femur of NHMUK PV R3898 also displays possible pathologies, including possible bite marks.

'*Steneosaurus obtusidens*' has been considered to be the largest-bodied Middle Jurassic teleosaurid (Young *et al.* in press b). Approximate body length estimates using the skull and vertebral column length of the 'S.' *obtusidens* holotype (NHMUK PV R3168) is around 5.3 metres. In comparison, measurements reveal that NHMUK PV R3898 is much larger than NHMUK PV R3168, indicating that R3898 would have been even bigger. Therefore, *Steneosaurus durobrivensis* is, currently, the largest known Middle Jurassic teleosaurid, being greater than 5.3 metres in total length.

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A TOOTHED TURTLE FROM THE LATE JURASSIC OF XINJIANG, CHINA AND ITS PHYLOGENETIC IMPLICATIONS

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Keywords: Testudines, *Sichuanchelys* sp., Junggar Basin, Wucaiwan Formation, Late Jurassic.

The fossil record reveals that turtles repeatedly adapted to a range of marine, freshwater, and terrestrial niches, and that most of these niches are still filled by turtles today (Ernst and Barbour, 1989). A notable exception is the niche of large-bodied, flat-shelled, big-headed turtles, exemplified by taxa such as *Naomichelys speciosa* from the Early Cretaceous of North America (Joyce et al., in press), *Kallokibotion bajazidi* from the Late Cretaceous of Europe (Gaffney and Meylan, 1992), *Mongolochelys efremovi* from the Late Cretaceous of Mongolia (Khosatzky, 1997), or *Meiolania platyceps* from the Plesitocene of Lord Howe Island (Gaffney, 1996). Isolated remains of taxa filling this niche are globally known from the Cretaceous and Cenozoic, but their phylogenetic relationships remain controversial (e.g., Gaffney, 1996; Hirayama et al., 2000; Gaffney et al., 2007; Joyce, 2007; Anquetin, 2012; Sterli et al., 2013). It is therefore unclear if these turtles originated from a common ancestor or if they represent disparate lineages that converged upon the same ecological niche. A particularly puzzling example is *Mongolochelys efremovi* from the Maastrichtian of Mongolia, because it is particularly isolated morphologically, geographically, and temporally from all other such turtles. Here we present the first known cranial material of the Late Jurassic turtle *Sichuanchelys* from the Junggar Basin, Xinjiang Autonomous Province, China. The skull of this taxon is particularly notable because it retains a series of palatal teeth comparable to those of *Kayentachelys aprix* from the Early Jurassic of North America (Gaffney et al., 1987). A phylogenetic analysis firmly places *Sichuanchelys* sp. as sister to *M. efremovi* and reveals that the *M. efremovi* lineage invaded the large-bodied, flat-shelled, big-headed niche independently from other such lineages.

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MICROANATOMY AND BONE HISTOLOGY OF PLACODONTIA

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Keywords: Middle Triassic, placodonts, life style, growth, life history.

Placodontia belong to the Sauropterygia, a successful group of marine reptiles that had been very diverse during the Middle Triassic in the Tethys and its epicontinental seas. Placodonts first appear in the early Anisian and are known until the Rhaetian (Late Triassic). They can be divided into an unarmoured placodontoid grade and the heavily armoured monophyletic Cyamodontoidea. The placodontoid grade contains three taxa: *Paraplacodus broillii* and two species of *Placodus*. Cyamodontoidea are more diverse, currently with at least nine genera. Placodonts have a unique morphology, with a massive and akinetic skull with a reduced but specialized dentition, enabling a durophagous diet. Cyamodontoidea show numerous armour plates fused into one or two dorsal, and in some cases, also a ventral armour shield. *Paraplacodus*, on the other hand, lacked any kind of armour plates and *Placodus* only shows a single row along its vertebral column. Placodonts lived in shallow water and were no fast swimmers but most likely bottom walkers, which fed on hard shelled diet.

Compared to other Sauropterygia (i.e. Pachypleurosauria, Nothosauria, Pistosauroida) placodontoids show a very special microanatomy and bone histology, which allows a taxonomical assignment of isolated bones at least on group level.

Placodonts grew not with a uniform bone tissue type and show besides different grades of organization in the parallel-fibred and lamellar bone tissue a variety of vascular canals and vascular canal organization. The unarmoured *Paraplacodus*, for example, has no medullary cavity or region and grew with for modern sauropsids typical, nearly avascular lamellar zonal bone tissue type. Also the heavily armoured *Psephoderma*, one of the stratigraphically youngest known cyamodontoids, shows lamellar zonal bone but has also a large medullary cavity surrounded by a perimedullary region and a distinct vascularity. *Cyamodus*, which was also armoured, has a reduced medullary cavity and grew with very special kind of parallel-fibred bone. Additionally, *Cyamodus humeri* are characterized by a high vascular density with mainly radial organized radial and longitudinal vascular canals, locally forming primary trabeculae. Interestingly, vascular density increases in *Cyamodus* towards the outer cortex, which is contrary to what is known from other aquatic vertebrates.

Differences in microanatomy and bone histology clearly suggest different life histories and life styles in Placodontia that prevented competition in the shallow marine environment and might be a key to their success and diversity.

FOSSIL LAGOMORPHA OF ITALY: THE STATE OF ART

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Keywords: *Lagomorpha, Neogene, Quaternary, Italy.*

Lagomorphs represent a minor component of small European mammal assemblages of the Cenozoic. However, at least 24 species have been identified in the fossiliferous sites of Italy. Many of them have been discovered in “normal” non-insular assemblages whereas most of them come from endemic insular faunas (Late Miocene Tuscany-Sardinian palaeobioprovince (pb), Late Miocene Apulian-Abruzzi pb, Plio-Pleistocene Sardinian-Corsican insular domain, Plio-Pleistocene Sicilian insular domain). Both Leporidae and Ochotonidae have been collected in Neogene and Quaternary sediments (Paleogene remains are unknown). Leporidae occurs with five or six genera: *Alilepus*, *Trischizolagus*, *Hypolagus*, *Oryctolagus*, *Lepus* and, possibly, with a sixth still undescribed genus. The Italian fossil ochotonids are assigned to three genera: *Paludotona*, *Prolagus* and *Ochotona*. In the Tuscany-Sardinian pb *Paludotona* cf. *etruriae* is found in the Baccinello V₀ assemblage (MN 11) and *P. etrusiae* in the Baccinello V₁ assemblage (MN 11/12). An advanced form, *P. aff. etrusiae* occurs in the Baccinello V₂ faunal assemblage (MN 12/13). In the Apulian-Abruzzi pb the oldest lagomorph is *Prolagus apricenicus* from fissure fillings of Gargano (*P. cf. apricenicus* has been collected also in Abruzzi) whilst in the most recent fissure fillings a more advanced species, *P. imperialis*, occurs together with the older form. The Gargano *Mikrotia-Hoplitomeryx* endemic fauna is considered Late Miocene (Turolian) in age. The Late Miocene (Late or latest Turolian, MN 13) mammalian assemblages from the Italian peninsula, belonging to the mainland (non insular) faunas, are characterized by the presence of *Alilepus meini* (Baccinello V₃), *Trischizolagus* cf. *maritsae* (Brisighella), *Trischizolagus* sp. (Borro Strolla and very probably Moncucco Torinese), *Prolagus sorbinii* or *P. cf. sorbinii* (Monte Castellaro, Velona Basin, Borro Strolla, Brisighella, Moncucco Torinese, Ciabot Cagna). Pliocene small mammal assemblages are rare in Italy. Lagomorphs of the Early Villányian age are assigned to *Hypolagus petenyii* (Cascina Arondelli) and to “*Prolagus savagei*” (Cascina Arondelli), very similar (possibly identical) to *P. aff. sorbinii* of the Early Villányian from Arcille and from the Late Villányian and Early Biharian localities of Upper Valdarno. Early Pleistocene (Late Villányian or Early Biharian) assemblages (from several sites) are characterized by the presence of *Hypolagus “beremendensis”* (=?*H. petenyii*), *H. aff. brachygnathus*, *Oryctolagus valdarnensis*, *Lepus terraerubrae* and *Prolagus italicus*. *Oryctolagus burgi* (Borgio Verezzi – Liguria, Early Toringian) and the extant species *O. cuniculus*, *Lepus europaeus*, *L. corsicanus* and *L. timidus* (a species reported from sites of Late Toringian age only) are recorded within the assemblages of Middle and Late Pleistocene. During cool-cold phases of the Middle and Late Pleistocene *Ochotona* sp. or *Ochotona* cf. *pusillus* occurs in the north-eastern regions of Italy. Pliocene Sardinian insular faunas are characterized by the presence of *Prolagus* aff. *figaro* and of Leporidae indet. (Mandriola). During the Early Pleistocene, these species are followed by *P. figaro* (Orosei, Capo Figari) and by a leporid belonging to a new species and probably to a new genus (Orosei). In the Middle and Late Pleistocene the ubiquitous and extremely abundant *P. sardus* is the only one lagomorph occurred in Sardinia (and Corsica). This species survives on both islands during the major part of the Holocene. In Sicily the endemic *Hypolagus peregrinus* is known from the site of Monte Pellegrino (Monte Pellegrino F(aunal) C(omplex)) of Early Pleistocene age. *L. europaeus* (= very probably *L. corsicanus*) is reported from the Castello F.C. (the most recent Sicilian F.C. characterized by the absence of endemic elements) of the Late Pleistocene.

REASSESSING THE (?)EARLY OLIGOCENE VERTEBRATE ASSEMBLAGE OF MONTEVIALE (VICENZA, ITALY)

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Keywords: systematics, vertebrates, (?)Early Oligocene, Italy.

The Monteviale caves are known since the beginning of the 18th century as a lignite resource and they were mined until 1952. The lignite strata are basically constituted of black shales and black lignite accompanied by marls and sandstones. They lie on explosive basaltic breccia originally formed by a volcanic apparatus raised within a lagoon where the Calcarenitidi di Castelgomberto, Early Oligocene in age, originated. During the mining activity many fossil remains were found and most of them are currently housed at the Museo di Geologia e Paleontologia dell'Università di Padova. The collection consists of about 300 specimens of fishes, amphibians, reptiles and mammals acquired by the Museum from 1875 to 1946.

The major goal of this research is the systematic revision of the vertebrate fauna of Monteviale which has not been exhaustively reviewed since the 1930's. Amphibians are represented by several specimens of tadpoles of palaeobatrachids; reptiles are represented by two species of chelonians, the trionychid *Trionyx* (s.l.) *italicus* and the geoemydid *Bergouniouxchelys vallisnerii*, and one species of crocodile. The poorly preserved and abundant crocodylian remains have been originally ascribed to *Crocodylus monsvialensis* and *C. dalpiazi*; both taxa are currently considered synonyms of *Diplocynodon ratelii*, a species rather common in the freshwater deposits of Europe from the Late Eocene to the Middle Miocene. However, some cranial and dental characters suggest that all crocodylian remains belong to a single species of *Diplocynodon*, distinct from *D. ratelii*. Among small mammals, the big bat *Archaeopteropus transiens* appears to be, despite its size, a microchiropteran while *Epapheliscus italicus* clearly differs from apfeliscids in having different dental characters. The systematic revision of the latter species and of *?Dyspterna helbingi* is still in progress. Among the large-sized mammals, about 100 specimens are referred to the rhinocerotid *Epiaceratherium bolcense*. This cursorial species represents the smallest rhino among the first European representatives of Rhinocerotidae and displays some plesiomorphic characters. *E. bolcense* is currently known only from Monteviale. The fossil collection of *Anthracotheirus monsvialense* includes about 100 specimens. The morphology of the low crowned teeth does not show a wide range of intraspecific variation with the exception of the sexually dimorphic canines. The small-sized *A. monsvialense* and the large-sized *A. magnum* (more recent and widely distributed) can be placed into a trend of increasing body mass, taking into account the extreme small size of the first Asian representatives of the genus. A few fossil remains represent the genus *Anthracochoerus*. The occurrence of at least two species (*A. stehlini* and *A. fabianii*) and a wide dental variability are probably related to the presence of different environments in the area. *Propalaeochoerus paronae* represents the oldest suoid in the European continent. Its closest relatives have been collected in South-East Asia and are Late Eocene in age. The systematic validity of this genus is still debated.

The vertebrate assemblage, including several species of marshy habitats, suggests an age close to the Eocene-Oligocene boundary. Most of the mammal fauna of Monteviale shows a clear affinity with older Southern Asian forms.

LATE MIOCENE AND PLIOCENE BONY FISHES FROM POPOVO (UKRAINE): NEW DATA ON PALEOECOLOGY AND PALEOGEOGRAPHY WITHIN THE LOWER DNIEPER BASIN

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Keywords: *bony fishes, Miocene, Popovo, Ukraine, paleogeography.*

Popovo locality of the fossil fauna was discovered in 2007. It is situated near Vasilevka, Zaporozhye region (Southern Ukraine). The section includes four heterochronous strata with numerous remnants of bony fishes, amphibians, reptiles and mammals: Popovo 3 (Late Miocene, MN 11), Popovo 2, Popovo 1 and Popovo 0 (Late Pliocene, MN 16). Fish remnants are represented by disarticulated bones (isolated teeth, visceral bones, fin rays, vertebrae and scales). Majority of them (n=1642) are derived from Popovo 3 (Late Miocene, MN 11). Other bones (n=55; 33; 27) are from the Pliocene of Popovo 2, Popovo 1 and Popovo 0, respectively. Faunal list includes 27 species belonging to 20 genera, 6 families (Cyprinidae, Cobitidae, Siluridae, Salmonidae, Esocidae, Percidae) and 5 orders (Cypriniformes, Siluriformes, Salmoniformes, Esociformes, Perciformes). Carp fishes are predominate in the composition of fossiliferous strata (except Popovo 2). Bony fish community composition of the Popovo locality is fairly typical for the Late Miocene and Pliocene of Eastern Paratethys.

The data in the qualitative composition of Popovo reflects the real situation in detail. Quite large river with moderate stream and well-warmed water flowed in this area in the late Sarmatian, 9-10.5 Mya. Favourable environment, abundant resources and a considerable ecotopic variety helped to increase the qualitative and quantitative composition of bony fishes. Later (8-9 Mya) river probably changed its course. It has led to the isolation of the former river bed area, which has become an oxbow lake. This hypothesis suggests a significant break in sedimentation, as well as a difference in species composition. Marked limitation of biotic resources due to local changes in the hydrological regime has led to the disappearance of typical reophiles, reduction the number of trophic specialized forms etc. Communications gap with river was partially restored in the Late Pliocene. These changes were accompanied by an increase in the species abundance and the approach of qualitative composition of the bony fish Popovo 1 community to the typical river ones. It can be assumed that Popovo 1 and Popovo 0 represent successive stages in the development of one cenosis. The gradual extinction of ichthyocomplex, followed by a decline in species diversity, could be a response to climate change, and the effect of scarce resources for the existence of a developed community of aquatic organisms.

Shark fauna from the Tertiary of Slovakia from the collection of the Múzeum Spiša in Spišská Nová Ves

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Keywords: *sharks (Chondrichthyes), collections, Museum of Spiš, Slovakia.*

The Museum of Spiš in Spišská Nová Ves acquired in 2005 a collection of paleontological material, which consisted of 1 120 pieces of shark teeth from the sites in the South of Central Slovakia (Horné Strháre, Príbelce and Plachtince), which were found in the sandy sediments of the Tertiary Medium-Miocene (Lower-Baden) epoch. This material contains in particular the genera of *Odontaspis* having some species of *Acutissimus* and *Carcharias cuspidatus*. They are followed by the genus *Isurus hastalis* and *retroflexus*. The genera of *Galeocerdo* and *Carcharhinus* are rarer. The genera *Notorhynchus* and *Mitsukurina* occur very rarely. In this way our Museum managed to broaden significantly the representation of fossil fauna of sharks in its paleontological fund which contains also the findings of the teeth of sharks from Central-Carpathian Palaeogene, which are, however, rare.

Museums are of great importance as unique databanks paleontological material. They are therefore an important element of professional and scientific institutions. Therefore it is important for the information on the content of the museums' collection funds to spread among public. In case of insufficient processing of paleontological collections there can co-operate palaeontologists of various museums but also of another scientific institutions from different countries of Europe for the appreciation of funds in the form of their determination. At the same time the rare information on paleontological sites, and on their geology and stratigraphy, may lead to interesting correlations, to common results and scientific conclusions.

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EOCENE ANTARCTIC FISH DIVERSITY PATTERNS REVISITED

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Keywords: *Chondrichthyes, Notothenioidei, Gadiformes, La Meseta Formation, climate.*

Fossil record analyses repeatedly exemplify that climate never has been stable, and that it influenced evolution, diversification patterns and distribution of organisms throughout Earth history. The evolution of fish faunas of the Southern Ocean, which is today delaminated by the Circum-Antarctic current is a very good example for this. The evolution of modern-day Antarctic fishes seemingly occurred as surface water temperatures plunged from ca. 20°C to the polar extremes of -1,86°C we find today. The Southern Ocean surrounding the Antarctic continent is unusual in several respects. There is, for instance, a relatively sharp discontinuity in surface water temperatures between Antarctic waters (3-4°C) and cold-temperate waters (6-8°C) outside the Circum-Antarctic current resulting in a distinct boundary called Polar Front Zone. Additionally, the present-day fish fauna is striking in its low diversity and highly endemic teleostean association. Interestingly, only 1.3% of the world's fish fauna occurs in the Southern Ocean although this ocean forms ca. 10% of the world's ocean surfaces. More than 55% of all Antarctic fishes belong to ice-fishes (Perciformes, Notothenioidei), which are remarkable in having developed special adaptive traits to cope with the extreme water temperatures (convergently evolved in Arctic cods). Moreover, these fishes have no unambiguous fossil record despite some putative remains from Eocene Antarctic strata. So far, all identified fossil fish remains have to be assigned to gadiform teleosts rather than notothenioids. Consequently, their evolutionary history and phylogenetic relationships are far from being understood. The rather low diversity of the contemporaneous Antarctic fish fauna most likely is related to habitat loss (reduced shelf areas due to glaciation), climatic perturbations and plate-tectonics. It has been shown by the senior author that Late Cretaceous fish faunas before the oceanographic isolation of the Antarctic continent are more diverse and contain abundant representatives of cosmopolitan groups. The high Campanian (Late Cretaceous) fish diversity of Antarctica, for instance, is related to a thermal optimum and the opening of trans-equatorial seaways.

Eocene strata of Antarctica have yielded the most diverse Paleogene ichthyofauna from the Southern Hemisphere to date, comprising cartilaginous and bony fishes. It generally is assumed that fishes disappeared at the end of the Eocene due to a cooling phase across the Eocene–Oligocene boundary (ca. 33.7 Ma), which finally resulted in the thermal isolation of Antarctica and the establishment of large Antarctic ice sheets. Paleogene Antarctic fishes are mainly known from marine deposits of the La Meseta and Submeseta Formations (Ypresian – Priabonian) on Seymour Island in West Antarctica and from Eocene strata of Mount Discovery in East Antarctica. Here we present local and beta diversity analyses of Eocene Antarctic cartilaginous fishes (sharks, rays, skates, chimaeroids) for each stratigraphic level (TELMs 2/3-7) based on literature data. Striking is the predominance of a single lamniform shark, *Striatolamia macrota* in all levels and associations. Chondrichthyan diversity increased from the lower towards the middle Eocene, when the climate changed to strongly seasonal and cool-temperate coinciding with a “polytaxic period” indicated by a remarkable increase in species diversity of many other oceanic groups. The chondrichthyan beta diversity, however, is rather low compared to other Eocene localities of the same age and the taxonomic composition is remarkable mixed. Striking is the first and last appearance of some cosmopolitan taxa in the La Meseta/Submeseta faunas. Chondrichthyan diversity decreases rapidly in the Submeseta Fm. (TELMs 6 and 7). Conversely, bony fish diversity seemingly increases towards the end of the Eocene. The reasons for this, however, momentarily remain ambiguous.

AUTOPODIAL ROTATION AS A MEASURE FOR STANCE AND GAIT IN SYNAPSIDA FROM EARLY PERMIAN TO LATE CRETACEOUS

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Keywords: Synapsida, autopodial rotation, autopodia, limbs, stance.

In animals with ab- and adduction of the stylopodium, autopodial rotation occurs during the propulsion phase. For fossil Synapsida this means that rotation of the zeugopodium was compensated within the autopodium: A) The bones are rotated and/or medially abducted in the autopodial joints. The excursion angles of rotation and abduction are reduced in forms with less autopodial rotation. Only in climbers with an optional parasagittal gait, the basal joints are usually ball joints with high mobility. However, these ball joints differ from the ellipsoidal joints with joint extensions in Synapsida with high autopodial rotation. B) The autopodium is rolled around an oblique axis running proximomedially-distolaterally through the distal ends of the metapodialia. Thus, the difference in metapodial length is related to the degree of autopodial rotation, provided they are aligned in the walking axis at the beginning of the stride. In Synapsida with a digital arcade (Kümmell & Frey 2012) the weight cannot be transferred to the middle part of the digits, so that the symmetry of the metapodium is a better measure for the degree of autopodial rotation than in most Sauropsida. Rolling of an asymmetric acropodium can also add to autopodial rotation.

Evolutionary stages of reduction of autopodial rotation were reconstructed:

Stage I: *Dimetrodon*: Asymmetric acro- and metapodium, highly mobile joints. **Stage II:** *Biarmosuchus* and *Titanophoneus*: Digits subequal in length, asymmetric metapodium, highly mobile joints. **Stage III:** non-mammalian Cynodontia: Reduction in asymmetry of metapodium and the freedom of rotation and abduction in autopodial joints. **Stage IV:** Early Mammalian (since *Erythrotherium*): Symmetric metapodium, only minute freedom of abduction and rotation in the middle joint. **Stage V:** Mesozoic Mammalia: No rotation and abduction in the middle joint.

The evolution of manus and pes is similar in all stages.

Autopodial rotation can be reduced, when propulsion is only provided by stylopodial rotation or when the limb movement becomes more parasagittal. In the forms, mentioned in stage I-V, the decrease of autopodial rotation is most likely connected to a more parasagittal limb posture.

The similarity of the degree of autopodial rotation in manus and pes suggests a similar degree of abduction of fore- and hind limb. This contrasts the strong dichotomy in the stance and gait of fore- and hind limb proposed by Kemp (2005) for early Therapsida. A continuous evolution to a more upright stance and gait in fore- and hind limb is most likely. Early Mammalian forms such as *Oligokyphus* and Morganocodontidae had an almost mammalian stance and gait with only little ab- and adduction of the stylopodium during the propulsion phase as was proposed by Sereno (2006), in contrast to Kielan-Jaworowska & Hurum (2006). The Mesozoic Mammalia had a nearly up to completely parasagittal gait.

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PRELIMINARY STUDY OF GROWTH MARKS IN FRESHWATER FISH AND TURTLE BONES FROM THE NEOGENE OF CHAD

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Keywords: ectotherms, fossil bones, growth pattern, diagenesis, palaeoseasonality.

The characterization of continental palaeoenvironments is critical to understand the environmental frame and constraints on biological evolution. While oceanic cores permit to get abundant data, palaeoenvironmental characterizations in continental domain suffer both of scarcity of proxies and complexity of microclimates. It is thus crucial to sought for new proxies to characterize continental environments notably their climatic component. In that context, we chose to explore the suitability and signification of growth mark pattern in freshwater fish and turtle fossil bones. Effectively, bone growth in ectotherms is partly controlled by ambient temperature but also by resources availability so that bone study might reveal seasonal environment fluctuations. This is indeed accepted and used for long by archaeologists to indicate fishing season, but never explored properly in palaeontology.

We sampled bony elements (fin spines, centra, ganoïd scales) from three fish taxa widely distributed in the African Neogene fossil record (*Polypterus sp.*, *Clarotes sp.* and *Lates sp.*), and bony plates of the freshwater turtle *Pelusios sp.* All fossils were selected from the four Chadian fossiliferous areas whose ages range from Late Miocene to Early Pliocene.

Thin sections were observed in both natural light and cathodoluminescence. First, comparison between natural light and cathodoluminescence observations helped to link the quality of the signal preserved with diagenetic process extent. Second, under natural light, we measured the thickness of successive bony layers along transects in the sections providing a well preserved record of growth pattern. The lateral variations in a same bony layer and the change in growth rate between successive ones were analyzed to discuss the robustness and significance of the bony growth pattern depending on the bone, the individual, and the taxon.

On the first, we observe that preservation of growth marks is independent to the external aspect of fossils, so that it is impossible to select a priori “good fossils” at sight. We also observe a site-dependant preservation quality which is consistence with general knowledge on preservation in fossiliferous outcrops.

On the second, we evidence that growth pattern depends on the type of bone and on the studied area on the bone so that certain ones will be preferred to study environmental change (whereas others are visibly under internal growth constraints that do not interest us here). This was indeed long yet done empirically by archaeologists when they study growth to infer season fishery. Then, since relevant bones and bony areas (i.e. fin spines body) are selected, it seems that we have a consistent environmental signal. Moreover, it seems that different species do not record a same signal in a same site. These variations might depend on differences in their ecology and thus in the fluctuation of the external constraints on their growth during a year. This first study provides enough data from the Late Miocene outcrop of Toros-Menalla to evidence seasonal variations registered in the growth of bones in the three fish taxa.

We conclude that only comparing the growth pattern in a same bone in a same taxon between sites of different age might provide information on seasonality change through time. More generally, these first results suggest that bone growth pattern might be a powerful tool to document seasonality in ancient times but that so far we still lack calibration in the modern to brace it.

**STRUCTURE AND FUNCTION OF THICKENED EPITHELIAL PLATES
(CORNULES) IN THE EXTANT PLATYPUS (*ORNITHORHYNCHUS
ANATINUS*) REVISITED WITH SEM AND CT**

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Keywords: *Monotremata, teeth, oral keratins, Ornithorhynchus.*

Without teeth, adult monotremes (egg laying mammals) masticate food using oral keratins on the palate, tongue, and mandibles (e.g., Poulton 1888b). Unique among living monotremes, juvenile duck billed platypuses, *Ornithorhynchus anatinus*, have teeth (e.g., Poulton 1888a, Simpson 1929, Green, 1937). As the roots of the juvenile teeth degenerate (e.g., Thomas 1889), the epithelium below the teeth thickens into epithelial plates, called cornules. Cornules found in the adults function in food processing in conjunction with other oral keratins. Imagery from scanning electron microscopy (SEM) of the epithelial plates show structures broadly similar to those found in other keratins. SEM images also show that cornules are subject to the same types of degradation in collections as baleen. New high resolution x-ray computed tomography images of the epithelial plates show the distribution of a series of tubes long known to exist in the plates. The tubes are a continuous conduit to the plate surface and may serve a sensory function or result from the ever-growing nature of the epithelial plate. The cornules are probably an adaptation to feeding in an environment with a high sediment load.

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ISE-MESHTOOLS, A 3D INTERACTIVE FOSSIL RECONSTRUCTION FREEWARE

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Keywords: 3D software, fossil reconstruction, anatomy atlas, semi-landmarks, scalar computation.

The use of computer-assisted techniques on CT and μ CT data offers the opportunity to analyze the morphology of fossils from a whole new perspective: reconstructions of incomplete and distorted specimens can be achieved, which permits to conduct comparative analyses of fossil and extant forms (Zollikofer and Ponce de León, 1995; Zollikofer et al., 1995). Over the last two decades, 3D data acquisition and computer-assisted techniques have grown increasingly popular among palaeontologists and palaeoanthropologists. However, so far, no standard 3D fossil reconstruction software has emerged; researchers either use commercial software which are not primarily designed for paleontologists or paleoanthropologists, or develop their own in-house software solutions. To my knowledge, most of in-house 3D software fossil reconstruction solutions are not currently publicly available, and in my opinion, the few solutions which are publicly distributed remain not user-friendly enough or lack important features. In this paper, I present a software that could fill this gap: ISE-MeshTools is a system for the processing and editing of series of 3D triangular meshes. This software provides a set of tools for editing, positioning, deforming, labeling, measuring and rendering sets of 3D surfaces. Features include: retro-deformation for un-deforming fossils/deformed specimens; point and curve primitives for placing the exact type of landmark points researchers are interested in; easy to use 3D interface for positioning and manipulating sets of surfaces and landmark primitives; advanced surface tagging, labeling and coloring possibilities (to allow for the creation of anatomy atlases); scalar computation and coloring (based for instance upon surface curvature/thickness). The first public version of the software will be released this year.

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EARLY EVOLUTIONARY HISTORY OF *LIBYCOSAURUS* (HIPPOPOTAMOIDEA, ARTIODACTYLA) IN NORTH AFRICA

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Keywords: Anthracotheriidae, Sahara, Late Miocene, dispersal events.

Extinct anthracotheres were morphologically and ecologically diverse ungulates with bunoselenodont cheek teeth that lived in swampy environments. These mammals are under the spotlight since they are considered as closely related to Hippopotamidae (e.g. Boisserie *et al.* 2011). Here we focus on their dispersal ability that have led palaeontologist to regard them as ungulate pioneers in most of the intercontinental dispersion events (Lihoreau and Ducrocq, 2007). We particularly focus on the evolution and geographic dispersion of the most recent African lineage that precede their definitive extinction from that continent.

The last African genus of anthracothere, *Libycosaurus*, firstly described as a dinosaur (Bonarelli 1947), was engaged in a form of semi-aquatic-lifestyle as indicated by the marked specialisation of its skeleton and its paleobiology (Lihoreau *et al.* 2006). This genus underwent a spectacular evolution in Africa in relation with the Sahara history by an important body size evolution, diet shifting and social modification (Lihoreau *et al.* 2014). However this evolutionary history is incomplete as the origin of the genus remains unclear.

We describe here original fossil remains of this genus, which were discovered in the Beglia Formation in east Algeria and central Tunisia. These fossil specimens permit to validate the species *L. algeriensis* Ducrocq *et al.*, 2001 that was questioned notably due to the few assigned material (Pickford, 2006). These new data document a basal morphotype for the genus and allow discussing the phylogenetic relationships of *Libycosaurus* within “anthracotheres” and the paleobiogeographic scenarios prior to the Saharan initiation.

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'BITE ME, DINOFANBOY': LOVEBITES FROM LUFENG COUNTY

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Keywords: prosauropod, Lufeng fauna, theropod teeth, bite marks, Hettangian-Sinemurian.

Over seventy years since it was first reported by Yang Zhongjian ('CC Young'), the Hettangian-Sinemurian Lufeng Formation of Yunnan Province continues to provide fresh insights into the Early Jurassic evolution of dinosaurs and other terrestrial fauna. The term 'Lufeng Formation' is now restricted to the unit previously known as the Lower Lufeng Formation or Series; within this revised nomenclature, the formation consists of two subunits: the older Shawan Member and the younger Zhangjia'ao Member, representing the former 'Dark Purple' and 'Deep Red' Beds, respectively (Fang et al. 2000). Excavation in the Shawan Member for a relocated ironworks at Qingliangshan (Lufeng County) has recently uncovered the remains of a new specimen of the sauropodomorph *Yunnanosaurus*, represented by disarticulated cranial material, most of the vertebral column, and limb girdle elements. Three shed theropod teeth, matching those of the contemporaneous *Sinosaurus triassicus* (Young 1948; Lida 2012) and ranging from 25-30 mm in crown height, were recovered among the specimen's pelvic elements. In July 2013, a further specimen of *Yunnanosaurus* (Young 1942) was recovered from a different locality (near DaWaShan), in the same formation. It consisted of three closely associated sequences of articulated vertebrae (cervical, cervico-dorsal, caudal). One of the cervicals displayed distinct signs of localised brittle deformation, and within 200 mm of this vertebra, 3 teeth and two tooth fragments were found. One of the teeth fitted well in one of the brittle deformation recesses in the centrum of the cervical vertebra, which is interpreted as a bite mark. Although the teeth are not as well-preserved as those from Qingliangshan, their form can clearly be identified as distinct from all other theropod taxa currently known from the fauna. Thus the Lufeng Formation continues to contribute to our sparse global knowledge of Hettangian-Sinemurian dinosaur fauna.

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EARLY-MIDDLE PLEISTOCENE FOSSIL GENUS *IBEROMYS* (RODENTIA, MAMMALIA) IN THE MEDITERRANEAN BASIN FOCUSED ON ITS OCCURRENCE IN ITALY

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Keywords: *Iberomys huescarensis*, *Iberomys brecciensis*, Early Pleistocene, Middle Pleistocene, Italian Peninsula.

The occurrence of the genus *Iberomys* is testified in Italy and the Iberian Peninsula from the Early Pleistocene on. The genus comprises two extinct voles: *I. huescarensis* in the Early Pleistocene and *I. brecciensis* (= *mediterraneus*) in the Middle to early Late Pleistocene. One extant vole, *I. cabrae*, has been present in Spain from the early Late Pleistocene, enduring right through to today. In Italy only the two fossil species have been found to date. The fossil record of *Iberomys* in Italy is poor in comparison with those in the Iberian Peninsula and southern France. *I. huescarensis* has been identified in Italy at the Rifreddo and Spessa sites, while *I. brecciensis* has been recognized at Zoppega 2, Montagnola Senese II, Isernia, Valdemino, Polledrara di Cecanibbio and Paglicci. A revision of the specimens of the genus *Iberomys* in Italy and a comparison with the fossil records of southern France and the Iberian Peninsula show that the origin of the Early Pleistocene species (*I. huescarensis*) is presumably in Spain. The origin of the species *I. brecciensis* is still unknown. It seems to appear at the same time in Italy and the Iberian Peninsula, and its extinction occurred during the late Middle Pleistocene-early Late Pleistocene in Italy, France and Iberia simultaneously. In general, the fossil *Iberomys* record in Italy is poor in comparison with those in southern France and the Iberian Peninsula. The species *I. huescarensis* is present in Italy around 800ka BP, and, as has been pointed out previously, its first occurrence in the Iberian Peninsula is around 1 Ma. Despite these data, and taking into account that for the moment there is no fossil record for the species in southern France, a parallel origin of the species in Italy and the Iberian Peninsula cannot be ruled out, evolving from different populations of *Allophaiomys nutiensis*. Then, the origin of *I. brecciensis* (= *mediterraneus*) is not too clear: it seems that it appeared at almost the same time in Italy (Isernia la Pineta) and in the Iberian Peninsula (level TD8b of Gran Dolina; Cuenca-Bescós et al. 2010), at around 600 ka BP. These data suggest the probable parallel occurrence of the species in Italy and the Iberian Peninsula, with a subsequent introduction to the south of France from one of the two peninsulas. Finally, the extinction of *I. brecciensis* seems to have occurred at the same time in Italy as in France and the Iberian Peninsula, where its last appearance is at the end of MIS6 - beginning of MIS5, at the sites of Paglicci (Berto, 2013), Moulou-Guercy and MTV-Sala de los Huesos (Hanquet, 2011).

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TESTUDO CATALAUNICA BATALLER, 1926 IN THE VALLÈS-PENEDÈS BASIN

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Keywords: fossil tortoises, Castell de Barberà, Sant Quirze, Abocador de Can Mata, Paleotestudo.

Testudo catalaunica Bataller, 1926 (Testudines: Testudinidae) is a species of medium-sized tortoise originally described from the locality of Sant Quirze (SQ; late MN7+8) in the Vallès-Penedès Basin (NE Iberian Peninsula). Bataller (1926) described three specimens (syntypes, two housed at the Museu de Geologia del Seminari de Barcelona, the other currently lost). Subsequently, Bergounioux (1958) described an additional specimen from the type locality (housed at Museo Geológico y Minero in Madrid), on which basis he erected *Testudo catalaunica* var. *irregularis*. The latter is nomenclaturally valid as a species group name, but considered a junior subjective synonym of *T. catalaunica* s.s. (e.g., Auffenberg 1974; Pérez-García and Murelaga 2013). Jiménez Fuentes and Martín de Jesús (1991) designated the specimen figured by Bataller (1926) as the lectotype. More recently, this taxon has been attributed to genus *Paleotestudo* Lapparent de Broin, 2000 (Lapparent de Broin et al., 2006a,b; Pérez-García and Murelaga 2013). We report previously-unpublished material of this taxon from the Vallès-Penedès localities of SQ and Castell de Barberà (CB, MN9?), as well as from the stratigraphic series of Abocador de Can Mata (ACM, MN7+8). The new material from ACM (several complete shells and multiple shell fragments) confirms an attribution to *T. catalaunica*, to which it had been only tentatively assigned on preliminary faunal accounts (Alba et al., 2006). The new material from CB (a complete shell and isolated plates) further allows us to ascertain the presence of *T. catalaunica* at this locality, thus likely extending its chronostratigraphic range to the earliest Vallesian (although the age of CB is still contentious). All this material, together with new remains from the type locality (partial shells and shell fragments), will enable in the future an emended diagnosis of *T. catalaunica*, which is characterized by a trapezoidal anterior plastral lobe as well as a subrectangular neural 1 with a marked posterior constriction (it becomes narrower behind the posterior sulcus of vertebral 1). Our assessment further indicates that *T. catalaunica* is not attributable to *Paleotestudo*, because it lacks the convex pygal (in males and females) considered diagnostic of this genus (Lapparent de Broin, 2006a), whereas the morphology of the shell borders (Lapparent de Broin, 2000, 2006a) is here considered as variable in testudinids. More detailed comparisons with other small-medium tortoise remains from late Aragonian to Vallesian localities from elsewhere in Europe would be required to evaluate the presence of *T. catalaunica* outside the Vallès-Penedès Basin, as well as its potential synonymy with other currently accepted taxa (such as *Testudo steinheimensis* Schleich, 1981).

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RE-EVALUATING SEXUAL DIMORPHISM IN *PROTOCERATOPS ANDREWSI* (NEOCERATOPSIA, PROTOCERATOPSIDAE)

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Keywords: sexual dimorphism, Protoceratops, geometric morphometrics.

Protoceratops andrewsi (Neoceratopsia, Protoceratopsidae) is a well-known neoceratopsian dinosaur from the Campanian-aged Djadokhta Formation of the Gobi Desert, Mongolia. Since the American Museum of Natural History expeditions during the 1920s, more than one hundred well-preserved skulls and skeletons have been unearthed providing information on the ontogeny and intraspecific variability within *P. andrewsi*. Several contributions (Gregory and Mook, 1925; Brown and Schlaikjer, 1940; Dodson, 1976) hypothesized sexual dimorphism in cranial features of this taxon. Both relative frill width as well as the presence of a nasal horn have been hypothesized to be sexually dimorphic. However, the conclusions of the early contributions on this topic (Gregory and Mook, 1925; Brown and Schlaikjer, 1940) were based on qualitative observations of a small cranial sample. Dodson (1976) applied multivariate statistics using linear measurements to assess sexual dimorphism on a larger sample of skulls. He concluded that postorbital width of the skull, nasal height of the skull and width and height of the frill can potentially distinguish “male” and “females”. However, this hypothesis has not been tested within the broader sample now available.

In order to re-evaluate sexual dimorphism in *Protoceratops andrewsi*, we applied two-dimensional geometric morphometrics technique using a 52 landmark configuration for 30 skulls in lateral and dorsal view. A priori sexual distinction of the individuals was done according to the criteria specified by Dodson (1976).

The 2D PCAs performed on the cranial sample highlighted a wide shape variation between juveniles, “males” and “females” and within each group. No evident separation occurs between groups in the morphospace, and “male” morphospace broadly overlaps “female” morphospace. Even when exploring the morphology of the skull without the frill and the frill alone, no sexual dimorphism appears in these regions. Therefore, previously identified “males” and “females” have similar cranial morphologies. Additionally, the performed MANOVAs did not highlight any differences in shape between the hypothetical “males” and “females”.

We also performed linear regressions between shape and size to explore if size was correlated to sexual dimorphism. The results showed that there is no clear separation between “males” and “females” at a given centroid size in all configurations under investigation. Similar results are highlighted by the several performed ANOVAs, which show a similar size between the hypothetical “males” and “females”.

The results of our work do not support the hypothesis of sexual dimorphism within *Protoceratops andrewsi*. Anatomical traits such as the nasal horn height and the height and width of the frill are not correlated with any sexual dimorphism, contrary to the suggestions by Brown and Schlaikjer (1940) and Dodson (1976). Instead, purported dimorphic cranial features are attributed to non-sexual intraspecific cranial shape and perhaps also to ontogenetic shape changes during growth.

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COELUROSAURIAN THEROPODS FROM THE ANDRÉS QUARRY (LATE JURASSIC. LUSITANIAN BASIN, PORTUGAL)

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Keywords: Dinosauria, Coelurosauria, Late Jurassic, Portugal.

The Andrés quarry is known since the 90s decade due to the description of the first record of *Allosaurus fragilis* out of North American Late Jurassic. Since that date several systematic field works were developed in this quarry. These works allowed the identification of a diverse vertebrate fauna, including fishes, sphenodonts, crocodylomorphs, pterosaurs and dinosaurs (Malafaia et al. 2010). Dinosaur elements are the most abundant fossils in the quarry and among them it is particularly common the presence of remains assigned to *Allosaurus*. Isolated elements, mainly teeth, belonging to small dinosaurs, some of them recognized as dromaeosaurid theropods are also relatively common. Herein, we report a set of elements, including three caudal vertebrae of small sized theropods collected in this quarry. The vertebral centra have lengths between 24 and 41mm. On all of the vertebrae the transverse processes are missing suggesting that they belong to the distal end of the tail. These elements can be referred to Theropoda on the basis of their strongly elongated centra with slightly concave articular facets. The morphology of the two specimens, MNHNUL/AND.100 and MNHNUL/AND.101, is similar and both are assigned to the same morphotype. The general morphology of these specimens is fairly similar to some distal caudal vertebrae referred to *Allosaurus*, and they share with them the great elongation of the centra relative to its height, and a similar extension of the prezygapophyses. However there are also striking differences. The posterior caudal vertebrae of *Allosaurus* are more strongly arched ventrally and have a broader ventral groove. The posterior caudal vertebrae on *Allosaurus* have a distinct bulge laterally near the base of the neural arch that is distinct of the crest present in these small specimens. These two vertebrae are assigned to coelurosaurians on the basis of a distinct lateral ridge on the centra and the significantly greater transverse width than height of the articular facets (Rauhut and Xu, 2005).

The specimen MNHNUL/AND.102 is quite distinct of the previously described vertebrae in the heart-shape contour of the articular facets and the relatively higher neural arch. This vertebra has a well-marked lateral depression on the dorsal end of the centrum. The presence of pleurofossa in posterior caudal vertebrae is uncommon in theropods but is described on some maniraptorans including *Ornitholestes* and *Coelurus* (Carpenter et al. 2005).

The specimens herein described supports the previously hypothesis about the presence of a form of small coelurosaurian theropods in the Andrés quarry. The record of this group of theropods known at the moment in the Late Jurassic of the Lusitanian Basin is very scarce and consists mainly on isolate teeth. The vertebrae from Andrés together with the holotype of *Aviatyrannis jurassica* Rauhut, 2003 constitute one of the scarce postcranial evidence of coelurosaurians known at the moment in this record.

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MORPHOMETRIC-PALAEOECOLOGICAL DISCRIMINATION BETWEEN TWO EPIVILLAFRANCHIAN *BISON* POPULATIONS OF THE WESTERN PALAEARCTIC

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Fossil bovids have been greatly used as habitat indicators. In the present study, a morphometric comparison between the Epivillafranchian (late Early Pleistocene) *Bison* material from Nea Apollonia (Greece; 1.2-1.0 Ma) and Untermassfeld (Germany; MIS 31; 1.05 Ma) is attempted, seeking the relation to specific palaeoecological associations. The studied fossil *Bison* (*Eobison*) sp. (Kostopoulos, 1997) and *Bison* (*Bison*) *menneri* Sher, 1997 is stored at the Museum of Geology and Palaeontology, Aristotle University of Thessaloniki, and the Senckenberg Research Station of Quaternary Palaeontology, Weimar, respectively. Various linear measurements were taken on adult complete metacarpals and astragali. In general two size groups were distinguished as the multivariate analysis (PCA) of several measurements on metacarpals and astragali has shown. This reasonable separation along Axis PC1 reflected overall size, which further resulted in a morphological distinction probably related to the sex. The PCA analysis also quantified the effect of overall size (and size-linked shape) to the discrimination of metacarpal morphological types. The PC axis 2 of an independent PCA based on three indices derived from the distal quartile, the mediolateral diameter of the distal articulation and the mediolateral diameter of the distal diaphysis, all divided with the maximum length, seems to be strongly and positively related with the distal part of the diaphysis. Furthermore, the smaller specimens of the Apollonia bison display a greater degree of robustness with rather rectangular epiphyses due to their shorter metacarpals and the increasing proximal and distal broadness compared to the Untermassfeld bison with a rather triangular outline in their distal end. In addition, the analysis of the astragali morphology showed that the specimens from Apollonia tend to have superior-inferiorly compressed body relative to the medial-lateral width compared with those from Untermassfeld, which appear more anterior-posteriorly expanded as the lateral length/minimum length ratio also revealed, which clearly reflects overall astragalus size. The greater transverse width of the tarsal, and possibly the tibial, articulations suggests a wider base and more medio-lateral support for that articulation. It is concluded that the specimens from each locality represent bisons adapted to different environments. The Apollonia bison differs from the Untermassfeld one both in size and morphology, bearing anatomical features that are related to a rather open/hilly, possibly lightly covered with bushes and tall grass, and dry habitat (Kostopoulos & Koufos, 2000). On the other hand, the Untermassfeld bison represent a morphotype that would favor side to side movements, indicating (gallery) forest habitats in a humid river valley (Kahlke, 2006). The results are consistent with the hypothesis of two distinct lineages of *Bison* appearing during the later part of the Early Pleistocene in Europe.

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ADDITIONAL DENTAL REMAINS OF THE MIDDLE EOCENE PRIMATE *ANCHOMOMYS FRONTANYENSIS* FROM THE SOUTHEASTERN PYRENEES: NEW INSIGHTS INTO ITS DECIDUOUS DENTITION

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Keywords: *Anchomomys*, Sant Jaume de Frontanyà, Southern Pyrenean Basins, Robiacian, Spain.

The genus *Anchomomys* has traditionally included the species *A. crocheti*, *A. pygmaeus*, *A. gaillardi* and *A. quercyi* found in several French and Swiss localities (Godinot, 1988). Recently, the new species *A. frontanyensis* from Barcelona Province has been described (Marigó et al., 2011), adding to the picture a whole amount of new information on the genus. Whereas most of the old-known remains consisted only of a few teeth (mostly upper or lower molars), and most of the species were defined taking into account very few elements, this new species contributed a lot to the knowledge of this small adapoid thanks to the recovery and description of almost the whole dentition (except for the upper and lower incisors).

The material recovered from the Middle Eocene (MP14-15) locality of Sant Jaume de Frontanyà (Moyà-Solà and Köhler, 1993) is still yielding interesting results. The new material comes from the 3C level, and corresponds to two M^{1-2} (IPS-74365 and IPS-82058) and one M^3 (IPS-82059), as well as a dp_4 (IPS-82060), a P_4 (IPS-82061) and two M_3 (IPS-82062 and IPS-82063). These extra teeth increase the sample known for this taxon, which already included more than 200 specimens at the time of publication. All the new recovered teeth are complete and very well preserved, including the dP_4 . The two dP_4 available at the time of publication were incomplete and damaged, and although their existence was mentioned in the supplementary material (Marigó et al., 2011), no accurate description was provided.

The dP_4 of *A. frontanyensis* is similar in length to the P_4 although more molarized and very buccolingually compressed. It presents a well-developed paraconid mesial to the protoconid and a short paracristid at the mesial end of the trigonid, ending very far away from the metaconid. The metaconid is more distal to the protoconid than in the lower molars, and the cristid obliqua reaches its tip. The buccal cingulid does not extend to the talonid.

To sum up, the new material, apart from increasing the sample size of teeth of *A. frontanyensis*, will allow future comparisons of the dP_4 with other anchomomyins such as *A. crocheti* and *Nievesia sossisensis* or other adapiforms. Moreover, even though the material recovered corresponds to a small sample, it reflects the high size variability of the M_3 of this species already discussed when it was defined.

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TEMNOSPONDYL ORIGINS IN PHYLOGENETIC CONTEXT: AQUATIC, AMPHIBIOUS OR TERRESTRIAL?

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Keywords: *Temnospondyli, Tetrapoda, phylogeny, lifestyle, outgroup.*

Temnospondyli is a group of Carboniferous to (in any case) Cretaceous tetrapods that is widely thought to contain Lissamphibia, although some controversy remains. Even without the extant amphibians, Temnospondyli spans the range from terrestrial adults to obligatorily aquatic ones. It used to be assumed that temnospondyls, and indeed tetrapods, are ancestrally amphibious or terrestrial as adults, so that aquatic temnospondyls must be secondarily so; often they were thought to be neotenic in analogy to most aquatic salamanders today. However, based on the finding that a clear-cut metamorphosis is not ancestral for Tetrapoda but is limited to lissamphibians and (other?) dissorophoid temnospondyls, Schoch (2001) floated the possibility that an aquatic lifestyle may be ancestral for Temnospondyli, so that terrestriality evolved several times within Tetrapoda. Supporting evidence may come from the finding (Schoch & Witzmann 2010; Witzmann 2013) that many aquatic temnospondyls replaced their external gills with internal gills in ontogeny. All extant tetrapods lack internal gills; the gills of tadpoles, though soon covered by a lid, are homologous to external gills and to the septa between internal gills. Alternatively, Schoch (2009) suggested that the original temnospondyl ontogeny is that of *Sclerocephalus*, in which only the oldest, best-ossified individuals were able to walk on land and maybe act as a dispersal stage between bodies of water.

Resolution of this question will depend not only on improved determination of the lifestyles of temnospondyl species, but also on temnospondyl phylogeny – yet, the latest analyses (Pawley 2006; Ruta 2009; McHugh 2012; Schoch 2013) find wildly divergent results. Outgroup choice is critical (Schoch 2013) in determining how the aquatic temnospondyls are distributed over the tree. Which outgroups to choose is a nontrivial question, because their interrelationships are unclear. Therefore I tackle the problem by an analysis of tetrapod phylogeny based on Ruta & Coates (2007). I find that the lissamphibians are not temnospondyls, but “lepospondyls”; that *Caerorhachis/Casineria* (indistinguishable: Pawley 2006) is the sister-group to all other temnospondyls, among which the likely amphibious *Balanerpeton* and *Dendrerpeton* form the sister-group to the rest; within the latter, the aquatic Dvinosauria and the mostly aquatic Stereospondylomorpha are not sister-groups, but are separated by *Eryops* (slightly more terrestrial than *Sclerocephalus*) on the stereospondylomorph side and the aquatic and/or amphibious “edop-oids” on the dvinosaur side. Amphibious adults thus seem to be ancestral for temnospondyls.

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PTEROSAUR BONE MASS AND PNEUMATICITY

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Keywords: pterosaurs, computer tomography, imaging, pneumaticity.

High-resolution computer tomography (CT) scanning is now commonly used to visualise fossils in three-dimensions, especially specimens that are fragile or problematic to prepare. The application of CT approaches to pterosaur fossils, however, has so far been uncommon; work to-date has focused on the cranial and axial skeleton of few taxa (*Anhanguera* and *Rhamphorhynchus*) gathering qualitative information (for coding and general specimen description) rather than quantitative measurements.

Here we report new quantitative data from CT scans of pterodactyloid pterosaur wing bones and previously published scans of pterodactyloid axial skeletons and wing bones that we use to evaluate bone masses and pneumaticity. Bone mass is estimated using the bone volume calculated from the CT scans multiplied by estimated density, while pneumaticity is quantified using air space proportion (ASP) – the volume of air present within a bone.

Our study is important because estimating the masses of large pterosaurs has been hugely debated; estimates presented here are substantially larger than previous ones, which suggests that pterosaur bones were substantially heavier than once thought. Our work also suggests that pterosaurs may not share the relationship seen in birds between skeletal mass and total mass, as previously proposed. In addition, contrary to earlier studies, our estimates for ASP vary within a single bone, being generally higher at the ends of the bone than in the shaft. This new observation, in particular, has major implications for pneumaticity estimates based on single cross-sections through bone. As most estimates are based on the shaft of long bones, and the ends actually show higher ASP, this means that pneumaticity may have been systematically underestimated in the past. Additionally, variation seen in ASP amongst different size classes may be related to increased bending stiffness in response to the greater flight pressures related to large size.

EUSUCHIAN MASS DEATH ASSEMBLAGE FROM THE LOWER CRETACEOUS OF CAMEROON

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Keywords: Cretaceous, Crocodylia, Eusuchia, Cameroon.

The earliest members of the Eusuchia (or modern crocodylians) are primarily recorded in early Cretaceous deposits of Europe. However, fragmentary remains suggesting they also occurred in Gondwana have been reported a number of times and recent studies have confirmed this with a few complete skeletons from South America and Australia. Nevertheless, their precise affinities are still debated and reasons for their under-representation in freshwater ecosystems when compared to non-eusuchian taxa remain unknown. Yet, the African record of Cretaceous eusuchians is poor.

Recent fieldwork allowed us to discover an exceptional concentration of articulated skeletons attributable to *Brillanceausuchus babouriensis* Michard, de Broin, Brunet, Hell 1990 from the Mayo Oulo Léré Basin (part of the Upper Benue trough), located in northern Cameroon about 5 Km from the Babouri-Figuil Basin, where the holotype material of *Brillanceausuchus* originates. The outcrop consists of a finely laminated siltstone mainly from alluvial and lacustrine deposits seasonally accessible when the riverbed dries out. At least 53 specimens, partly or completely preserved, were identified in the field, either in cross-section or on slab surfaces over a stratigraphic height of about 10 meters. To a few exceptions, the skeletons are articulated, with a maximum total body length of less than a meter, and systematically preserve gastroliths. This preliminary field survey exclusively identified crocodylians at that site, raising ecological and taphonomical questions for such an apparent selective mass death. Finally, the yet unprepared newly discovered specimens provide some novel insights into the affinities of *Brillanceausuchus babouriensis*.

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FISH TROPHIC GUILDS IN THE PALAEOECOLOGY OF LAS HOYAS (CUENCA, SPAIN)

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Keywords: *amiids, growth patterns, age distribution, trophic network, Early Cretaceous.*

Trophic networks are representations of the feeding interrelationships among different organisms within a community. Buscalioni et al. (in press) recently developed a first attempt of a trophic network for Las Hoyas palaeocommunity (Barremian, Early Cretaceous). In that paper, the trophic information has been coded at species level; in other words, the vertices that constitute the trophic web are species. The analysis of this network has resulted in the occurrence of groups with the same trophic relations, either being prey or predator, which are termed trophic guilds. Each trophic guild, thus, includes a number of different taxa with similar feeding habits. In that first attempt, however, these resulting trophic guilds lack the information concerning the ontogenetic development of the different taxa. Most of the species change their feeding habits throughout the distinct stages of their life cycles; thus, our working hypothesis is that a single species could be part of several trophic guilds. This is particularly relevant in fishes, which are the most abundant vertebrates of the association and a key component of its trophic network. For this reason, we think that understanding the autoecology of the particular species, and especially how they grow and how their populations behave, will greatly improve the resolution of their trophic relations.

In the present project, the age and growth characteristics of three amiiform fishes from Las Hoyas (two amiids and a probable basal amiiform) have been studied in detail to elucidate population characteristics that indicate ontogenetic changes in trophic position. Evidence of habitat partitioning is an indicator or niche partitioning. For this purpose, we identified the growth cessation marks present in different skeletal structures, but mainly in scales, which are the most representative sample of the populations. Growth cessation marks are deposited during specific environmental events (e.g., seasonality) or during spawning. The age distribution and growth rate of each species are estimated from quantifying and measuring the distance between growth cessation marks. We conclude one of the species has a much faster growth rate and a higher longevity than the other two. For example, one amiid species is smaller and lives only to 12 years old. The other amiid species is significantly larger and lives to 18 years old. All three taxa grow slower than other extinct amiiforms and the only extant species *Amia calva*. The age distribution histograms of these species show populations greatly dominated by juvenile forms (mode = 0-1 years old). However, the presence of very large isolated scales belonging to much older specimens reveals the existence of large adult individuals. The fact that these older, larger individuals are extremely rare at the site suggests habitat partitioning occurs among sizes; that is, older adult specimens live in a different place than the younger adults and juveniles. This suggests that, effectively, the different ontogenetic stages of these species cannot be included in the same trophic guild, but have to be segregated into several ones. Inclusion of ontogenetic-based trophic guilds in the Las Hoyas trophic network is necessary to accurately portray the ecological patterns of fishes.

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**THE PLEISTOCENE CAMELIDS FROM EL KOWM, SYRIA:
A CRANIUM FROM THE SITE OF NADAOUIYEH AÏN ASKAR**

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The origins and most of the evolution of camels (Camelidae, Artiodactyla) took place in North America, where they were an endemic and highly successful family from the middle Eocene (~45 Ma) to the late Miocene (~7 Ma). Subsequently, they dispersed into Eurasia and South America, the only continents where native camels survived until the present. While the early history of the family is well studied, the Eurasian and African fossil species (assigned to the genera *Paracamelus* and its offshoot *Camelus*) are mostly based on poor material or on old, scanty description.

The fauna of the El Kowm Basin (central Syria) provides a good opportunity to study the evolution and diversity of Pleistocene camelids. The rich Palaeolithic archaeological sites of this region are dated from 1.8-1.5 Ma to 50 ka and have also provided abundant fossil mammals, among which camelids represent the most frequent element in all layers. Our preliminary observations suggest that the varied succession includes several forms, likely representing undescribed species.

Here we describe a relatively complete cranium, which is among the best specimens yet recovered from El Kowm and one of very few fossil camel crania found in Eurasia. It originates from the level 7 of the site of Nadaouiyeh Aïn Askar, a layer otherwise almost barren, and is dated to the Middle Pleistocene (about 450 ka). The rostrum and the zygomatic arches are missing; the dentition and the basicranium show important damage. The cranium is close in size to a recent Bactrian camel (*Camelus bactrianus*), and is larger than that of a dromedary (*C. dromedarius*). It is closely similar to both extant species and can readily be assigned to the genus *Camelus*; however it differs from either in several metrical and morphological characters and shows some unique traits. The face and the frons are broad and convex, but the palate is relatively narrow. The postorbital constriction is shallow and in a posterior position. The morphology of the orbits is highly distinctive. M¹ is long and broad, while M² and M³ are narrow. The age of the individual is estimated at approaching 7 years. The low sagittal crest suggests that it was a female.

Because of its mosaic of features, it cannot be readily decided if this species is closer to either modern species, or more distantly related to both. Forthcoming comparisons with the known fossil species will show if this cranium can be chosen as holotype of a new species.

NEW BIRD TRACKS FROM OLIGOCENE SUBALPINE MOLASSE DEPOSITS OF SCHANGNAU (CENTRAL SWITZERLAND)

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Keywords: bird ichnology, ichnotaxonomy, subalpine Molasse, Oligocene, Switzerland.

Bird tracks from Cenozoic Molasse deposits of Switzerland are known since 1945 (short review in de Pietri et al., 2013). Here we describe new well-preserved bird tracks, discovered 2012 in a remote, small streambed near Schangnau–Bumbach, (Emmental, Canton Bern, Switzerland). The tracks are preserved in positive relief as track casts on the lower bedding plane of a large sandstone bloc (> 2 m in diameter), that can be correlated with a massive sandstone bed of the fluvialite Oligocene “Honegg-Mergel-Formation” that crops out just above the streambed, where the bloc was found. As the bloc was too heavy to be flown out by a helicopter, a cast of the track-bearing surface and a high-resolution photogrammetric documentation of the surface was made in order to document these tracks. Two different bird track morphotypes were identified: (1) Type I tracks are large (maximum length of up to 15 cm) with three or four digit impressions, of which digits II–IV are always present and directed forward while digit I is spur-like, short and directed backward but only impressed occasionally. The axis of digit I is slightly offset to the prolongation of digit III. Some tracks present a prominent central pad, phalangeal pads and claw marks, whereas there is no evidence for webbing in any of these large tracks. Two short trackways have been identified. The irregular occurrence of digit I can be explained by small lateral differences in substrate properties at the time of track formation or, more likely, to the behaviour of the trackmaker, which may or not have transferred its weight to the posterior part of the foot during each step, or he was able to move digit I independently. (2) Type II tracks are tiny tridactyl tracks (maximum length of 1-2 cm) with slender digits directed forward and not jointed proximally, although in some cases digits II and III are almost connected. Impressions of digit I and a central pad are never preserved. These tracks are very shallow and only visible in good lighting conditions. There is some evidence for trackways, but as the areas where these tracks are preserved are moderately trampled, they can not be identified unambiguously. Based on their morphological characteristics, the two morphotypes can be tentatively attributed to the ichnotaxa *Gruipeda* and *Avipeda* (*sensu* Sarjeant & Langstone, 1994; de Valais & Melchor, 2008), respectively. However, Sarjeant & Langston considered the latter ichnotaxa (*Avipeda*) as a “wastebasket” because of the high number of defined ichnospecies and the likely presence of many synonyms.

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COMPARISON OF MODERN AND FOSSIL CROCODYLOMORPHA EGGS AND CONTRIBUTION TO THE OOPHYLOGENY OF AMNIOTA

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Keywords: oophylogeny, Crocodylomorpha, Amniota, egg and eggshell, rugosocavate pore system.

Eggshells from three extant crocodylian species – *Crocodylus mindorensis*, *Paleosuchus palpebrosus*, and *Alligator mississippiensis* – has been analyzed and described. A comparison between these and other extant and fossil crocodylian eggs showed that the egg external surface ornamentation may vary between the anastomo- and the ramotuberculate (*sensu* Carpenter 1999) types, and the newly described rugosocavate type, characterized by an irregularly rugose surface scattered by subcircular pits that not always correspond to pore openings (Marzola *et al.* 2014). On the pore canals system, Crocodylomorpha are characterized and pooled with some dinosaurian and avian groups by the angusticaniculate type, made of single, straight and subcircular pores with a diameter, in our samples, between 100 and 130 nm and a relative low area percentage of 0.08–0.22% per cm² on the eggshell total area (Ribeiro *et al.* 2013; Marzola *et al.* 2014). A diagnostic evidence of incubation in crocodylian eggs is the presence of pits and stepped concentric erosion rings around the pore openings, due to the microbiological degradation of the outer eggshell surface during the incubation and appreciable on our *P. palpebrosus* sample. Although Crocodylomorpha exhibits a stable and well defined eggshell morphology, with slight structural variations throughout the entire clade, we reported for the first time a unique organization and morphology of the eggshell ultrastructure in *P. palpebrosus*, with a thin middle layer showing a dense and compact tabular microtabular horizontal lamination, in opposition to the sparse lamination present on the outer layer.

The Monotremata stays at the base of the Amniota oophylogenetic tree, with a primitive eggshell condition of a leathery, parchment-like, flexible, thin, proteic membrane enveloping the egg (Stewart 1997). A hardly mineralized eggshell is synapomorphic of the Sauropsida, which also presents a trend in hardening through further mineralization. An aragonitic amniotic eggshell is synapomorphic of the clade Chelonia, while all other amniotes are characterized by a calcium carbonate eggshell (Carpenter 1999; Kohring 1995). In the Archosauria, Pterosauria is characterized by an unusual eggshell morphology, made by a leathery, thin, and low mineralized eggshell, with low degrees of variation throughout the entire clade (Unwin & Deeming 2008). Crocodylomorpha, Dinosauria and Aves have a hardly mineralized, rigid eggshells, an organic core at the base of each eggshell unit, and a higher porosity, although the Dinosauria show a greater variability in the eggshell structure (Carpenter 1999).

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VERTEBRAL DIVERSITY AND VARIATION IN SAURICHTHYID FISHES: PHYLOGENETIC PATTERNS AND DEVELOPMENTAL ASPECTS OF THEIR EVOLUTION

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Keywords: Actinopterygii, Saurichthyidae, pleomerism, axial skeleton.

Factors influencing variation in vertebral numbers in fishes are poorly understood, although the variability of these characters is well-documented. Body size and shape, latitude, temperature, life history, swimming style and phylogenetic relatedness have all been correlated with variation in vertebral numbers (McDowall, 2008).

Saurichthyidae, a speciose family of Triassic fishes, shows a large range of body sizes, with the smallest taxon measuring only 150 mm in total length, and the largest over 1200 mm. Extensive variation in the number of vertebrae is recorded both within and between species. Previous work suggested that no relationship exists between body shape and the number of abdominal or caudal vertebrae in saurichthyids (Maxwell and Wilson, 2013), and attributed this finding to doubling the number of neural arch-like elements per myomeric segment. This raises questions about which factors, if not body shape, are most important in influencing variability in meristic counts within the clade. We examined the influence of size on vertebral count within a single species, *Saurichthys curionii*, as well as between 14 saurichthyid species with phylogenetically independent contrasts, in order to determine whether vertebral numbers and body size are correlated in these fishes.

We found no relationship between body size and vertebral count when all individuals referred to *Saurichthys curionii* were included in a single analysis. However, when males were excluded from the sample, variation in length was positively correlated with variation in vertebral numbers. Females had more vertebrae than males at a given size. The same relationship was recovered between the size-standardized length of the abdominal region and the number of abdominal vertebrae, with male fish having fewer abdominal vertebrae for a given axial length than females. In contrast, there was no correlation between maximum length of the vertebral column and total number of vertebrae across species, suggesting that although vertebral numbers are correlated with intraspecific variation in body size in saurichthyid fishes, the number of vertebrae is not related to body size evolution in the group.

We conclude that within a species, vertebral numbers are related to both body size and sexual dimorphism. This finding may explain the relatively high levels of intraspecific variation observed in the vertebral counts of *S. curionii* when compared with extant fishes. As vertebral numbers are determined early in embryogenesis, sexual dimorphism in this character eliminates any possibility that *S. curionii* was a sequential hermaphrodite. Over longer evolutionary time scales, body size appears to have been decoupled from the number of vertebrae, possibly related to changes in the structure of the vertebral column within Saurichthyidae.

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AN EAGLE OWL FROM THE EARLY PLEISTOCENE OF CAL GUARDIOLA (VALLÈS-PENEDÈS BASIN, IBERIAN PENINSULA) AND VARIATION WITHIN EARLY *BUBO*

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Keywords: fossil birds, *Bubo*, Early Pleistocene, Iberian Peninsula.

The fossil record of the eagle owls, genus *Bubo*, extends back into the Miocene, but Neogene and Early Pleistocene records of *Bubo* in Europe are scarce and mainly constituted by non-diagnostic or very fragmentary specimens. Apart from a number of extinct *Bubo* species of uncertain affinities—i.e., *B. floriana* Kretzoi, 1957, *B. lignitum* Giebel, 1860, and *B. perpastus* (Ballman, 1976; Mlíkovský, 1998), material was left unassigned or determined as *Bubo bubo* on the basis of their size (Mlíkovský 2002), especially the Early Pleistocene records.

The site of Cal Guardiola (Vallès-Penedès Basin, Iberian Peninsula) which documents the latest Villafranchian faunas of Europe (ca. 1.2-0.83 Ma; Madurell-Malapeira et al., 2010), has yielded a tarsometatarsus that appears to be intermediate in morphology and size in between the eagle owl *B. bubo* and the snowy owl *B. scandiacus*. Comparisons of the Cal Guardiola specimen to other fossil *Bubo* taxa from the Early and Middle Pleistocene suggest that there was significant morphological variation within the genus *Bubo*. For example, the tarsometatarsus from the Early Pleistocene Cromer Forest Formation described by Harrison (1979) is very slender compared with modern *B. bubo*. From the early Middle Pleistocene of France, Mourer-Chauviré (1975) described two extinct *Bubo* subspecies, i.e. *B. (Nyctea) scandiacus gallicus* and *B. bubo davidii*, that are both larger than their recent counterparts.

The observed morphological variation in fossil *Bubo* reflects the degree of variation shown by the different species of *Bubo* currently living in Africa and Asia, and thus it may suggest the presence of several *Bubo* taxa in Europe before the Middle Pleistocene. These taxa have now been replaced by *B. bubo*, while *B. scandiacus* now occupies the extreme northern part of the continent.

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A LARGE NEW TETRAPOD TRACKSITE FROM THE TRIASSIC OF THE WESTERN SWISS ALPS (LA VEUDALE; VIEUX EMOSSON FORMATION, LATE OLENEKIAN TO ANISIAN)

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Keywords: archosaur footprint, track preservation, palichnology, *Chirotherium*, fluvial sedimentology.

Several new sites with tetrapod tracks were recently discovered in the Vieux Emosson Formation of the Aiguilles Rouges Massif around Lac d'Emosson (Finhaut, Western Swiss Alps). The lower, 3-10 m thick unit of the Vieux Emosson Formation overlies highly-weathered, pre-alpine paragneisses with more than 1 m of local (and up to >10 m over a few km) erosional relief. It consists of conglomerate and sandstone beds with m-scale fining upward sequences. The mottled, dm-thick, red sandstone beds contain cm-scale angular carbonate nodules and large desiccation cracks. The interbedded sandstone and mudstone facies transition into the overlying shale contains the track-bearing levels as well as abundant current and wave ripple marks, mudcracks, mudstone rip-up clasts and rare load casts. Paleocurrent data from troughs and ripples have an unimodal distribution pattern indicating northwest transport direction towards the depocentre of the Germanic basin.

The conglomerates and sandstones were deposited in shallow braided streams, whereas fine-grained facies are interpreted as floodplain and playa lake deposits. A fluvial regime is also supported by the high-relief basal erosional surface, immature sediment, large angular clasts, amalgamated fining-upward sequences, mottled paleosol horizons, quasi absence of bioturbation, and an unimodal paleocurrent pattern.

The new La Veudale locality is close to the historical tracksite of Vieux Emosson and is the largest site so far. It includes two surfaces covering 1500 and 950 m², with more than 1500 pes/manus tracks in concave epirelief and some indistinct trackways. The new site sheds light on the wide preservational and extramorphological range of variation of the Vieux Emosson tracks. Around many of the tracks, low relief concentric rings may indicate the former presence of a microbial mat, that was intended outwards by the pressure of the foot. Characteristic features of the digit proportions of the better-preserved specimens permit a re-evaluation of the ichnotaxonomy, and an assignation of these tracks to *Chirotherium barthii*, *C. sickleri* and *Isochirotherium* cf. *herculis*. Because of their similar size and overall morphology, we infer that the majority of the tracks of the La Veudale and Vieux Emosson localities belong to these ichnotaxa. Tracks previously identified as tridactyl, "dinosauroid" pes tracks are re-interpreted as incomplete pentadactyl chirotheriid tracks, and there is no evidence for a dinosauroid origin of any of the tracks. Accordingly, the track assemblage clearly is a typical chirothere assemblage, comparable with those from the central European Buntsandstein of the Germanic Basin. It can be referred to the *Chirotherium barthii* biochron constraining the age of the Vieux Emosson tracksites to the Late Olenekian–Anisian (late Early–early Middle Triassic) interval.

THE NEW MESSEL EXHIBITION AT HESSISCHES LANDESMUSEUM DARMSTADT

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Keywords: *new exhibition, Messel-Fossils, background information.*

The Hessisches Landesmuseum Darmstadt (HLMD) is one of the oldest public museums in Germany, and one of the few museums in Europe that combines under one roof extensive exhibitions on geology, paleontology, mineralogy and zoology with just such of art and art history. The collections date back to the last quarter of the 18th century. The historical museum's building was planned by Alfred Messel, a widely known architect at that time. It was firstly opened in 1906 and reopened in 1955 after a partial destruction during the second world war. In 1984, an additional building was added for the arts of the 20th century. In October 2007, it was closed again for a complete renovation which was needed due to structural deficiencies in both buildings. All exhibitions and collections were moved into external repositories and buildings, together with the workshops, offices and staff. This inconvenient period is now approaching to an end. We hope that another reopening can take place during this summer.

HLMD houses the oldest and one of the most important collections of fossils from Messel Pit. This is an abandoned open-cast mining which is situated about 9 km NE of the city of Darmstadt (Hessen State, S Germany). It became world-famous, especially for its excellently preserved Middle-Eocene (47 Ma) mammals, and was inscribed into the UNESCO World Heritage List in 1995. The Messel collection of HLMD comprises numerous type specimens and some famous and outstanding rarities, like several specimens of the small, primitive horses of the genera *Propalaeotherium* and *Eurohippus*, the primeval tapir-like *Hyrachyus minimus*, and the unique anteater *Eurotamandua joresi*.

The Messel show specimens were formerly integrated into the regular public exhibition, which was mainly arranged according to systematic and stratigraphic aspects. In 1979, they were firstly presented in a separate section. The complete exhibition of the geological and paleontological department was rearranged in 1996. The same thing just happened once again, and also with all other public exhibitions of HLMD. Concerning the Messel section, the ground area increased from about 100m² to more than 330m² and the number of specimens from 80 to 265.

The new exhibition will be subdivided into two parts. One will be dedicated to the different compartments of the ancient habitat, like the treetops, the rainforest floor or the ancient maar lake and its immediate surroundings. Sight slits with photorealistic scenarios will show how these peculiar sections of the former habitat may have been looking like, together with their inhabiting plants and animals. Special topics will be covered in thematic digressions, and also in dynamic legends. These are interactive elements with which the visitors can retrieve additional digital information like movies and/or graphs.

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NEW ADVANCES IN THE KNOWLEDGE ON THE MICROCHOERINAE (PRIMATES) FROM THE IBERIAN PENINSULA

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Keywords: Eocene, Paleogene, Omomyidae, Primates, Spain.

The family Omomyidae includes a group of early primates that were abundant and diverse during the Eocene in the Northern Hemisphere. They were small-bodied primates, similar to living galagids in locomotor adaptations, generally nocturnal and with insectivorous or frugivorous diets. Within them, the exclusively European subfamily Microchoerinae is recorded in the Eocene with few exceptions lasting into the Early Oligocene. The first works describing microchoerine remains from the Iberian Peninsula were undertaken in the 1960s. After that, works dealing with this group are sparse and mainly based on scarce material. By contrast, the advance in the knowledge on microchoerines from Spain has increased strikingly in the last four years due to the work carried out by the team of the Institut Català de Paleontologia Miquel Crusafont, including the study of classical collections and the prospection of new areas.

The most significant contributions refer to the genus *Pseudoloris*. The material from Sant Jaume de Frontanyà-3 (Middle Eocene, Eastern Pyrenees) allowed the description of the species *P. pyrenaicus* and the recognition of several morphological changes in the early evolution of the genus (Minwer-Barakat et al., 2010). Soon after, the species *P. cuestai* from Mazaterón (Middle Eocene, Duero Basin), showing a particular morphology of the incisors, was interpreted as an endemic form from the Western Iberian Bioprovince (Minwer-Barakat et al., 2012a). Recently, the study of some unpublished remains from Sant Cugat de Gavadons (Late Eocene, Ebro Basin) led to the redescription and designation of a neotype for *Pseudoloris reguanti*, whose holotype and unique material was lost (Minwer-Barakat et al., 2013a). Regarding *Microchoerus*, the description of two mandibles of *M. aff. erinaceus* from Zambrana (Late Eocene) represents the first finding of a primate from the Miranda-Trebiño Basin and the westernmost record of the genus in the Iberian Peninsula (Minwer-Barakat et al., 2013b).

Other works are in course, although some preliminary results have been presented (Minwer-Barakat et al., 2012b, 2014). They include the description of new material of *Pseudoloris parvulus* from Sossís (Late Eocene, Pyrenean Basins), representing the richest collection of the genus described from the Iberian Peninsula; the report of new material of a large microchoerine from the same site, previously ascribed to *M. erinaceus*, which most probably will be described as a new species; and the study of a small *Necrolemur* from Sant Jaume de Frontayà-1, which represents the oldest record of the genus from Spain. Moreover, continuous fieldwork is yielding new material from several sites. All these findings are contributing to increase the record of microchoerines across Europe, allowing a better understanding of their biodiversity.

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FIRST APPROACH ON THE LIFE HISTORY OF *PROLAGUS APRICENICUS* (OCHOTONIDAE, LAGOMORPHA): A GIANT FOSSIL FROM THE GARGANO'S PALEOISLAND (ITALY)

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On island, small mammals become giants, while large ones become dwarfs. This tendency of insular mammals to converge in body size is coined the island rule. The different ecological pressures that govern island ecosystems (low predation and limited resources) do not only trigger changes in body size but also in the species' life history. Up to now, dwarfing has attracted special attention in studies of the island rule, but little is known about the curious giants. The presence of lagomorphs is well known both from extant and past insular ecosystems. Thus, this order provides the opportunity to focus on the shift of life history strategies in small insular mammals. The current Gargano peninsula (Apulia, Italy) formed in the past an archipelago inhabited by a highly unbalanced fauna that presented all the features of insular endemics. Principally composed by a large number of rodent species and by remarkable large mammals (hoplitomericids), the fauna also stands out for the presence of two *Prolagus* species: *P. apricenicus* and *P. imperialis*. These species are characterized both by significant evolutionary changes in dental morphology and by a marked increase in size compared to its mainland forerunners. *Prolagus apricenicus*, presented in all the fissures of *Terre Rosse*, is smaller and less derived than *P. imperialis*, which is only localized in the youngest fissures. The distinct endemic traits of these lagomorph species make them suitable for evolutionary researches on islands.

With the goal to shed light on the biology and life history (age at maturity and longevity) of insular lagomorphs, we conducted estimations of body mass and paleohistological analyses using *Prolagus apricenicus* femora. The material was recovered at the Cava Fina F8 site assigned to the latest Miocene (phase 3). The regression models between body mass and femoral epiphyseal diameters (transversal and anteroposterior) provide an estimated weight of about 600 g for the small Gargano's *Prolagus*. This contrasts with the 300 g estimated for *Prolagus cf. calpensis*, the Late Pliocene ochotonid from Casablanca I, Almenara, Spain. Bone histology of an ontogenetic series of femurs was analyzed under polarized microscopy. The cortices of the smaller femurs show fast-growing fibrolamellar tissue. Additionally, larger femurs also display slow-growing lamellar bone in the outermost cortical layer, some of them showing several LAGs. These latter are considered sexually mature, though the epiphyses are still unfused.

CATARRHINE EVOLUTION UNDER THE LIGHT OF THE MIDDLE MIOCENE FOSSIL RECORD FROM ELS HOSTALETES DE PIEROLA (CATALONIA, IBERIAN PENINSULA)

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Keywords: primate fossil record, Middle Miocene, Abocador de Can Mata, Hostalets de Pierola, hominoid evolution.

Reliable reconstruction of the evolutionary history of primates is highly dependent on the quality of the fossil record. However, primates, by their ecological and life-history characteristics, are rare elements in past paleobiocenoses. Quantity and quality of the specimens, as well as of the contextual chronostratigraphic and paleontological data, are key aspects that determine the bonanza of the outstanding sites. The Middle-Late Miocene primate fossil record of the Hostalets de Pierola section in general (Vallès-Penedès Basin, Catalonia, NE Iberian Peninsula), and of Abocador de Can Mata (ACM) in particular, is, in this sense, exceptional. An intensively sampled 250 m-thick Middle Miocene stratigraphic section has provided more than 250 fossil sites, of which more than 20 have yielded primate remains, some of them of exceptional quality. The primate fauna includes a new, undescribed small catarrhine of uncertain affinities, as well as pliopithecines (represented by *Pliopithecus* and related forms; Alba et al. 2010) and members of the Hominidae. The latter show a previously unexpected high generic diversity, including *Pierolapithecus*, *Anoiapithecus*, and *Dryopithecus* (Alba 2012). The good quality of some of these findings, including the partial skeleton of *Pierolapithecus catalaunicus* (Moyà-Solà et al. 2004) and the undescribed new small catarrhine partial skeleton with skull, provides a bulk of new information that will importantly contribute to the development of hypotheses on hominoid evolution. This fact is especially relevant if we take into account that current debate focuses on the apparent incongruence between the ancestral crown-hominoid and hominid morphotypes, as reconstructed on the basis of the features shared by extant taxa (and supported by molecular evidence), and the contrasting morphotype evidenced by the fossil record (which does not fit with this model derived from extant taxa). The current fossil evidence supports the view that homoplasy has played a dominant role in hominoid evolution. Fossil evidence, hence, seems to lend support to the current notion that parallelism and convergence underlies a significant portion of the similarities postcranial morphology displayed by the various groups of extant hominoids (Larson, 1998).

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A NEW GOURAMI (TELEOSTEI: ANABANTOIDEI) OF PROBABLE EOCENE AGE FROM SUMATRA

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Keywords: *Anabantidae, Channidae, Osphronemidae.*

Fossil fishes from the Sangkarewang Formation cropping out in the Ombilin Basin in Sumatra, Indonesia, were first collected in the 1870s. A comprehensive study of these fishes was not published until almost 50 years later, at which time a number of fishes were described but most were placed within living taxa (Sanders, 1934); this contributed to the idea that the deposits were of a relatively young, Miocene age. However, the age of the Sangkarewang Formation is not confirmed, and has been variously attributed to the Cretaceous, Palaeocene, Eocene and Miocene, with Eocene being the presently favoured estimate. New fossils from the Sangkarewang Formation were collected in 2009, and included among this material is a single, small anabantoid fish. Although Sanders (1934) had previously described an anabantoid from the site, this new specimen is not conspecific with any of the material described previously, and is considered to be a new genus and species. A phylogenetic analysis of the relationships of the new taxon shows the new anabantoid to be closely related to the living giant gourami genus, *Osphronemus* and we place it in the gourami family Osphronemidae; however, the phylogenetic analysis did not recover this family as monophyletic. This new gourami and another previously described from the same locality are the only fossil anabantoids known. However, much of Sanders' (1934) material has since been lost, leaving this new specimen as the only fossil gourami known to exist in a public collection.

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A NEW QUANTITATIVE APPROACH TO THE PALAEOECOLOGY OF CONFUCIUSORNITHIFORMES

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Keywords: bird, morphometrics, palaeoecology, Mesozoic.

Confuciusornithiforms are a group of basal pygostylian birds with a unique combination of primitive and derived characters, known from a handful of species from the celebrated 'Jehol Biota' localities in Northeastern China. Particularly remarkable is their cranial anatomy, combining a primitive complete diapsid condition and a putatively akinetic skull with the presence of a complete edentulous beak surrounded by a horny sheath; the first occurrence of this trait in avian evolutionary history and convergent with their modern counterparts (Neornithes).

Although more than two hundred specimens of the type species (*Confuciusornis sanctus*) are known, the palaeoecology of these animals remains fairly obscure. Regarding the feeding behaviour, qualitative ecomorphological correlations have pointed to a variety of trophic alternatives: from raptorial or piscivorous, to folivory, seed-eating, or generalistic omnivory. Furthermore, a specimen of this species preserves fish remains associated with the neck region, putatively pointing to at least some fish content in the diet of these birds.

However, no quantitative analysis of the ecomorphology has been performed to our knowledge, neither on these animals nor in Mesozoic birds as a whole. Here we undertake a geometric morphometric analysis on the skull and snout region of all the valid species of confuciusornithiforms (4 in total), along with 37 species of extant avians (comprising 18 orders), 8 Mesozoic birds, and 12 non-avian dinosaurs. The taxa were selected in order to be as phylogenetically diverse as possible, capturing the main stages of early avian evolution and some of the evolutionary events towards a shift to herbivory-omnivory in theropods. Also, they were selected to be morphologically disparate within the main trophic categories we are focussing on: raptorial, piscivorous, generalistic omnivores, and different herbivorous regimes.

11 homologous landmarks were selected to cover the skulls, with 50 semilandmarks comprising the snout region shape. The overall aim is to seek the strongest ecological signal to the exclusion of evident phylogenetic effects, hence, the morphospace was generated without plotting the underlying phylogenetic relationships.

We predicted that confuciusornithiforms would cluster in the morphospace together with generalistic herbivores or omnivores, which is the most congruent hypothesis on the light of the majority of qualitative ecomorphological work in the literature. Additionally, other correlations between the taxa shed light on the palaeoecology of some of the other extinct birds, whose niches are not well understood currently.

This research is forms part of a larger multidisciplinary project seeking to assess the palaeoecology of confuciusornithiforms. Biomechanical studies will be performed in the near future to complete the picture of the biology of these animals and their role in Upper Cretaceous ecosystems.

EVOLUTIONARY HISTORY OF THE ACQUISITION OF A SEMIAQUATIC LIFESTYLE IN HIPPOPOTAMOIDES

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Keywords: *petrosal, inner ear, Anthracotheriidae, amphibiosis, Hippopotamidae.*

Since molecular data have identified hippos as the closest living relatives of cetaceans (e.g., Miyamoto & Goodmann 1986; Irwin et al. 1991), anatomists have been looking for paleontological evidence that would fill the morphological gap between these two highly divergent taxa. Indeed extant hippos and cetaceans have nothing much in common, except characters related to their strong relationship with the aquatic environment. Both groups present morphological similarities of the ear region and striking behavioural similarities, such as underwater suckling, or underwater communication by bubble blasts. Accordingly, a common aquatic/semiaquatic ancestor hypothesis for the group gathering Hippopotamidae and Cetacea – namely Cetancodonta – had naturally been proposed (Gatesy et al. 1996; Geisler & Theodor, 2009). Surprisingly, if the question of the aquatic affinities of the first cetaceans has been investigated at large, it has not been the case for hippo forebears. Recent phylogenetic studies including a large sample of extant and extinct Hippopotamidae (Boisserie et al. 2010; Orliac et al. 2010), as well as recent total evidence analyses (i.e. treating together molecular and morphological data; Gatesy et al. 2012), gather Anthracotheriidae (paraphyletic) and Hippopotamidae (monophyletic) within the Hippopotamoidea clade.

Interestingly, several anthracotheriids have been interpreted as amphibious animals, either based on isotopic analyses (e.g., $\delta^{18}O$), cranial morphology, or skeletal morphology. Specifying the life-style of “anthracotheriids” is crucial to reconstruct the evolutionary history of amphibiosis within hippopotamoids. Besides, determining if hippopotamoids were primitively semi-aquatic is a first necessary step toward establishing whether or not hippos and cetaceans inherited their underwater skills from a common ancestor. Here, we question the aquatic affinities of fossil hippopotamoids through an investigation of the auditory region including the middle and inner ear of nine anthracotheriid taxa encompassing the suprageneric diversity of the superfamily. Our results indicate that amphibiosis is not an ancestral feature of hippopotamoids and that similarities of the ear region morphology observed in hippos and cetaceans result from convergences. We show that underwater directional hearing appears during the latest Eocene and that at least four independent specializations to full-time immersion during the day occurred in hippopotamoids.

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NEW INSIGHTS INTO THE SYSTEMATICS OF RHINOCEROTIDAE FROM THE LATE MIOCENE OF MARAGHEH (IRAN)

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Keywords: *Rhinocerotidae*, *systematics*, *palaeobiogeography*, *Late Miocene*, *Iran*.

The Maragheh fauna is well known in literature for the exceptionally abundant and well-preserved mammal remains (Bernor et al., 1996; Ataabadi et al., 2013 and references therein). This fauna is subdivided into three biostratigraphic intervals: "Lower Maragheh" (LM), "Middle Maragheh" (MM) and "Upper Maragheh" (UM) that spans a time of ca. 1.6 Ma (from ca. 9 Ma to 7.4 Ma, latest Vallesian-earliest Middle Turolian; Bernor et al., 1996; Ataabadi et al., 2013). Since the end of the 19th century, the collected taxa from Maragheh have been studied in several contributions; however, the rhinocerotid material has not been exhaustively reviewed. The goals of this research is the systematic revision of the rhinocerotid material collected from the sites of Maragheh and currently housed at Naturhistorisches Museum of Wien and Natural History Museum of London. The results of this study allows to provide new considerations on the systematics, biochronology and palaeobiogeography of the Maragheh rhinocerotids.

The scarce remains of elasmothere *Iranotherium morgani* are reported from the MM localities (e.g., Ketschawa), but a few postcranial elements, collected at Kopran (LM), can be ascribed to this species extending its biostratigraphic range. This taxon also occurs in mid-Bahean (= latest Early Vallesian-Late Vallesian) faunal assemblages of Linxia Basin (Western China). The most abundant rhinocerotid material in the Maragheh fauna belongs to the acerathere *Chilotherium persiae*, collected from several localities of LM and MM. The dental morphology of *C. persiae* is similar to that of *C. habereri* from China (in particular relative to the more advanced forms from Baode Fm, late Middle Turolian-early Late Turolian). The rhinoceros *Ceratotherium neumayri* is usually reported from the MM (e.g., Kara Kend and Ketschawa). However, the type of the species was collected at Kopran (LM) along with some postcranial remains. The earliest occurrence of *C. neumayri* is reported from the Early Vallesian of Anatolia (Turkey). The species also occurs in the Middle and Late Turolian of Samos and Pikermi (Greece). The westernmost boundary of the *C. neumayri* distribution is usually placed in the Balkan Peninsula. However, we ascribe the rhinocerotid material from Gravitelli (Sicily, Italy) to this species. Within the revised material, some specimens cannot be referred to the three species mentioned above. A few postcranial remains collected at Kara Kend (MM) clearly differ from *C. persiae*, resembling to *Acerorhinus* morphology. Moreover, a fragmentary skull with maxillae collected at Kopran (LM) displays some morphological features that allows to distinguish it from the three species of Maragheh. This specimen, belonging to a new species, seems to be distantly related to *Acerorhinus*.

In this work we provide evidence of the presence of at least four rhinocerotid species at Maragheh. *I. morgani* and *C. neumayri* occur with a new acerathere species in the LM. *I. morgani* dispersed from China to the Maragheh area. *C. persiae* and "*Acerorhinus*" sp. nov. display morphological affinities with Chinese taxa, suggesting similar dispersal pattern. *C. neumayri* probably dispersed from the Anatolia to Eastern and Western areas.

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NEW DATA ON THE FOSSIL BIRD ASSOCIATION FROM THE EARLY PLIOCENE OF LANGEBAANWEG, SOUTH AFRICA

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Keywords: *Langebaanweg, Pliocene, birds, Accipitriformes, Strigiformes.*

The Early Pliocene Upper Varswater Formation (Langebaanweg, South Africa) is one of the most important pre-Pleistocene fossil localities in Africa. The study of the fossil birds from Langebaanweg started at the beginning of the 1980s, when Rich (1980) reported the presence of at least 60 species representing 28 bird families. Several papers were published on various bird groups since then, but studies on many taxa are still in progress. Up to now the studies of this very rich fossil bird bone assemblage revealed the presence of more than 90 species of 35 bird families (Manegold et al. 2013), making Langebaanweg one of the richest fossil avifaunas in the world.

Most recently, a new species of an aegyptine vulture (Manegold et al. 2014) as well as five species of owls (Strigiformes) were identified (Pavia et al., submitted). The new vulture species represents the earliest, unequivocal and most substantial evidence for crown-group Aegypiinae in the world. Evidence for an Aegyptius vulture at Langebaanweg indicates that open woodlands were an important component of the early Pliocene palaeoenvironments at this particular site. Owls are represented by a new species of *Tyto* (Tytonidae) as well as representatives of the strigid genera *Asio* and *Bubo*, which form the earliest records for these taxa in Africa. Especially remarkable is the first evidence for a species of *Athene* south of the Sahara, which is also the earliest record for an *Athene* owl worldwide. Modern representatives of all these owl taxa can be found in a great variety of habitats, but the composition of the owl assemblage at Langebaanweg might be congruent with latest hypotheses on local palaeoenvironments based on other taxa.

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MINIATURIZATION AND MORPHOLOGICAL CHANGE: A PALAEOONTOLOGICAL APPROACH

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Keywords: *miniaturization, Temnospondyli, Dissorophoidea, morphometrics.*

Miniaturization is a phylogenetic concept, which has been defined as the evolution of extremely small adult size in a lineage. It does not simply imply the decrease of the body size of the adult; but also involves structural modifications to functional efficiency. Miniaturization might be a key factor for the phyletic diversification above the species level and the evolution of major clades. In particular, current hypotheses propose that at least one of the living amphibian groups originated from a Permian clade, the miniaturized dissorophoid temnospondyls.

Herein we analyzed for the first time the cranial shape variation among miniaturized and non-miniaturized dissorophoids in a phylogenetic context in order to identify patterns of morphological change in miniaturized forms. We also evaluated whether these evolutionary patterns resemble ontogenetic ones by studying the ontogeny of *Micromelerpeton credneri*, a basal dissorophoid. Although some characters have been associated with miniaturization in the clade, they have never been tested quantitatively, nor has the non-independence of the data considered, such as by common ancestry. We collected quantitative data by geometric and traditional morphometric techniques and analyzed them by phylogenetic comparative methods.

Logarithms of size variables were regressed on logarithms of the skull length. The regressions of the interspecific data were made by phylogenetic generalized least squares. Taking into account the linearized allometric equation $\ln y = a \ln x + b$, the slope of the linear regressions ('a') was interpreted as the allometric coefficient.

In agreement with previous qualitative observations, the morphometric analyses within dissorophoids showed a negative allometry (i.e., 'a' < 1) of the orbit size, and a positive allometry (i.e., 'a' > 1) of the posterior position of the jaw articulation relative to skull length. The same pattern was recovered from the ontogeny of *M. credneri*, suggesting that proportionally bigger orbits and more rostrally positioned jaw articulation in small dissorophoids are paedomorphic features. The otic notch length presented negative allometry among species, whereas the size of the otic capsules showed a positive allometry, the latter contradicting previous hypothesis. Given that both structures grow isometrically (i.e., 'a' = 1) in *M. credneri*, the large otic notches and small otic capsules of miniaturized dissorophoids do not seem to be the result of developmental truncation.

In conclusion, the reduction of body size in temnospondyls led to quantifiable changes in skull shape, which cannot be completely explained by paedomorphosis. In this regard, future studies focused on the deviations from developmental truncation will probably shed light on functional constraints and on the adaptive significance of structures.

THE CRANIAL MORPHOLOGY OF VALLÈS-PENEDÈS DRYOPITHECINAE (PRIMATES, HOMINIDAE): TAXONOMIC IMPLICATIONS

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Keywords: Hominoidea, Miocene, Pierolapithecus, Anoiapithecus, Dryopithecus.

The hominoid cranial remains recovered during the last decade in the Vallès-Penedès Basin (NE Iberian Peninsula) (Moyà-Solà et al 2004, 2009a,b; Pérez de los Ríos et al., 2012) have shown a greater diversity of Miocene Dryopithecinae than previously recognized (Alba, 2012). However, the taxonomic validity of the genera *Pierolapithecus* and *Anoiapithecus* has been disputed (e.g., Begun, 2009). Here we compare the external and internal cranial morphology of these taxa from a taxonomic viewpoint. Based on the lower face IPS35026, *Dryopithecus fontani* is characterized by a long and high face, short and oval premaxilla, U-shaped, deep and wide palate, high nasoalveolar clivus with an open palatine fenestra, wide nasal aperture (widest at the base) and high zygomatic root over M¹. *Pierolapithecus catalaunicus*, based on the splanchnocranium IPS21350 (holotype), is characterized by a wide interorbital area with a non-swollen glabella, absence of frontal sinus, long nasals with a wide nasal aperture (widest at the base), high zygomatic root over M¹ with a zygomatic recess of the maxillary sinus, U-shaped deep and wide palate, long muzzle with a short premaxilla, and high and short nasoalveolar clivus. Finally, based on the parical face IPS43000 (holotype) and other maxillary remains (IPS35027 and IPS41712), *Anoiapithecus brevirostris* is characterized by a high and orthognatous face, very broad interorbital region with extensive frontal sinus under the glabella, moderately high zygomatic root above M¹, wide nasal aperture (widest at the base), very short and oval premaxilla, deep and wide V-shaped palate that narrows anteriorly, short nasoalveolar clivus and open palatine fenestra. *Anoiapithecus* differs from *Pierolapithecus* and *Dryopithecus* in the anteriorly narrower palate shape, the most anteriorly located infraorbital rim (over the premolars), the less laterally-oriented zygomatic and the more orthognatous face; it also differs from *Dryopithecus* in the shorter premaxilla; and *Pierolapithecus* also shows a stronger midfacial projection and a more posteriorly situated nasion than *Dryopithecus* and *Anoiapithecus*, and a zygomatic recess of the maxillary sinus (absent in the other genera); it also differs from *Anoiapithecus* in the lack of frontal sinus (not ascertainable in *Dryopithecus*). Finally, *Dryopithecus* is larger in size and displays a more posteriorly located zygomatic root than *Anoiapithecus* and *Pierolapithecus*, with a higher malar surface than the latter. Overall, our results support the distinctiveness of the three Middle Miocene dryopithecine genera recognized at the Vallès-Penedès Basin.

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DISENTANGLING THE POSITIONAL BEHAVIOR OF EUROPEAN MIOCENE HOMINOIDS: EVIDENCE FROM THE INTERNAL STRUCTURE OF THE FEMORAL NECK

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Keywords: femora, cortical thickness, Vallès-Penedès Basin, Hominoidea, locomotion.

The biomechanical properties of the femoral neck cortical bone (FNCB) closely reflect the positional behavior of extant primates. The primate femoral neck transmits body weight and muscle loadings through the hip complex. Depending on the type of loading, the FNCB exhibits different patterns of organization: extant hominoids that heavily rely on antipronograde behaviors (i.e., below-branch suspension, vertical climbing, bridging and clambering) show a symmetric distribution of cortical bone through the mid section of the femoral neck, whereas quadrupedal monkeys and bipedal humans exhibit relatively thicker FNCB inferiorly, reducing the strain suffered in this area due to more stereotyped loadings at the hip joint. In the last years, the FNCB distribution has played an important role for endorsing bipedal behaviors in early hominins, assuming that extant apes show the plesiomorphic condition for crown hominoids and that bipedal humans are derived. The femur of the extinct great ape *Hispanopithecus laietanus* from Can Llobateres 2 (ca. 9.6 Ma) shows the first fossil evidence of a modern ape-like symmetrical distribution, supporting that a symmetrical FNCB distribution is the plesiomorphic condition for hominids (the great-ape-and-human clade). To expand previous results and provide more detailed evolutionary scenarios, in this study we analyze FNCB distribution through the mid-neck and base-of-neck in IPS18800 (*H. laietanus*) and the older specimen IPS41724 of the extinct great ape cf. *Dryopithecus fontani* from Abocador de Can Mata ACM/C3-Az (ca. 12 Ma). FNCB was inspected through computed-tomography (CT) scan images and compared to a published sample of extant apes and humans, as well as fossil hominins. IPS18800 overlaps with extant great apes and departs from modern human in both measures. Inspection of IPS41724 images is challenging due to extreme mineralization of the fossil, resulting in CT images with noisy and poorly-defined areas on the superior half of the femoral neck. This complicates obtaining a reliable measure for the superior cortical thickness in both sections. Nonetheless, the inferior cortex seems notably thicker, progressively decreasing through the anterior and posterior edges, becoming thinner superiorly. Preliminary estimates for this specimen suggest that its FNCB distribution is modern ape-like at the mid-neck (i.e., close to symmetry), but intermediate (not overlapping) between African apes and humans (i.e., more asymmetric) in the base of the neck. In this respect, IPS41724 is similar to the pattern of some South African australopiths. These results support previous evidences of the diversity in the positional behavior of Miocene European hominoids, and are compatible with previous inferences (based on femora and other postcranial remains) that *Hispanopithecus* exhibited a wide locomotor repertoire including a high degree of below-branch suspension. Conversely, cf. *Dryopithecus* would exhibit more stereotyped loadings at the hip joint, compatible with a generalized “Miocene ape-like” quadrupedalism. The older age of the femur attributed to cf. *Dryopithecus* might suggest that it more likely exhibits the great ape plesiomorphic condition. These results also rise the question as to whether early hominins are derived or plesiomorphic relative to the original great ape condition in this respect. Obviously, more fossils would be necessary to test these hypothesis.

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GENOME WIDE ANALYSES OF LATE PLEISTOCENE AND EARLY HOLOCENE MODERN HUMAN REMAINS FROM EUROPE

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Keywords: *mtDNA, SNP, paleogenomics.*

Studies of ancient human mitochondrial DNA (mtDNA) suggest genetic continuity between Upper Paleolithic and Mesolithic hunter-gatherers in Europe, followed by an almost complete replacement with limited genetic admixture by Neolithic farmers (Bramanti et al. 2009). The analyses of both partial and complete mtDNA of pre-Neolithic European individuals revealed a high frequency of mitochondrial haplogroups belonging to clade U, the oldest known haplogroup originated in Europe (Soares et al. 2010). By contrast, early Neolithic European farmers were found to belong mostly to mtDNA haplogroups that evolved more recently with similar frequencies to modern contemporary Europeans (Fu et al. 2012). MtDNA however reflects only a single genetic locus that is maternally inherited and therefore can only provide a limited view on the genetic impact of Late Pleistocene and Early Holocene human populations on present-day Europeans. Recent work on genomic data from pre-Neolithic European individuals revealed low genetic diversity between geographically distant hunter-gatherer groups (Skoglund et al. 2012, Olalde et al. 2014) and a varying contribution to European genetic variation (Lazaridis et al. 2013). These results were achieved through whole genome shotgun sequencing of single individuals with outstanding preservation of human DNA. For most ancient human samples such an approach would however not be economical due to the low percentage of endogenous human DNA. In this study high-throughput sequencing technologies are adopted first to reconstruct the complete mitochondrial genome of Late Pleistocene and Early Holocene European individuals in order to authenticate and evaluate the preservation of ancient DNA. Second, on the selected samples new methodologies are applied to enrich for certain single nucleotide polymorphisms (SNPs) that have been already genotyped on large panels of present-day modern human populations (Lazaridis et al. 2013). This approach allows the parallel capture of selected nuclear variants while having enough resolution to assess how an ancient European is related to modern individuals as well as to other ancient human samples. Adopting this technology will permit to analyze a wider range of ancient human remains reducing the sequencing costs and making feasible to generate genome wide data from individuals through time and space.

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AN EXCEPTIONAL SMALL VERTEBRATE FAUNA FROM THE LATEST MIDDLE MIOCENE OF AUSTRIA

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Keywords: palaeoecology, micromammals, Miocene, Austria, biogeography.

The late Middle Miocene is fascinating for the study of terrestrial palaeoecosystems: following the long period of the Middle Miocene Climatic Optimum, drastic climatic changes induced important faunal re-arrangement and migration within Europe. Rich and diverse fossil faunas are thus of primary importance for the understanding of these processes. The late Middle Miocene is well recorded in various Iberian basins, but complete faunas of this period are rare in Central Europe. Therefore, the recent discovery of an exceptional fossil assemblage of macro- and micro-vertebrates in Gratkorn (early Late Sarmatian, Austria, Styria), allows a fresh look on the palaeocommunity following the Mid-Miocene cooling.

Based on the degree of corrosion on the dental elements and the presence of pellets, most, but not all, of the small mammal remains (19 species) are tentatively interpreted as a result of accumulation by nocturnal raptors. Probably, part of the fossorial individuals of the lower vertebrate (including two fish, eight amphibian and 17 reptile taxa) might have been buried in situ, maybe in their own burrows in the sandy soil

Lower vertebrates, small mammals and molluscs occur in abundance in the same thin fossil enriched layer, and give a mixed picture of the environment: relatively sparsely vegetated floodplain with sandy soils, including short-lived ponds, streams or rivulets in the close vicinity, relatively open landscapes, with a dry, semi-arid climate. Indications of „forested area“ are indicated by the gliding mammals.

This could indicate the presence of different microhabitats around the excavation place, but may also be a taphonomical artefact based on various different agents of accumulation contributing to the thanatocoenosis. Nevertheless, the extreme quick accumulation (decades?) of the fossils.

NOTES ON DEVELOPMENTAL MORPHOLOGY OF OLIGOCENE TRACHINID FISH *TRACHINUS MINUTUS*

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Keywords: *Trachinus*, fish, ontogeny, morphology, Oligocene.

Oligocene fish fauna of the Polish Carpathian is represented by number of species (see Jerzmańska 1968) including also trachinid *Trachinus minutus* (Jonet, 1958). Specimens are of maximal size about 35 mm, whereas recent species of the genus *Trachinus* Linnaeus, 1758 can reach up to 35 cm. This disproportion, together with obvious not-finished ossification of the specimens lead us to deduction that Oligocene species is represented by larvae, juveniles and sub-adult specimens. Studying of these specimens introduces specific problems related with allometric growth and interpretation of unfinished morphological structures.

Collection of *Trachinus* specimens from the Hermanowa locality is represented by numerous individuals. The head length of the smallest specimen is just 3.5 mm (caudal part of the specimen is not ossified enough and therefore unrecognizable). The skull roof, otic part of the skull, lower jaw, maxillae, anterior most part of the premaxillae, preopercles, cleithra, anterior part of the first dorsal fin, and ventral fins' spines are well developed already in this stage. Ethmoidal part of the skull, ectopterygoid, opercles and corpus quadrati are more or less recognizable, but obviously in the initial stages of their morphogenesis. There are preserved ca 22 vertebrae in the vertebral column (they are less and less distinctive posteriorly as the ossification decreased posteriorly). Other elements are not developed or distinctive yet.

The smallest individual with complete spine is represented by specimen with SL ca 10 mm and it is possible to classify it as early postflexion larval stadium.

During later stages of ontogeny continue ossification of skull, there appeared the last spine of the first dorsal fin (in SL ca 17 mm), anal and second dorsal fins starts to form, etc.

Morphology of some bones change rapidly during ontogeny and their presence is conditioned by particular age. For that reason it is necessary to take into account the ontogenetic status of the specimens during planned revision of the fossil trachinids.

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DIVERGENCE OF PRIMARY TURTLE LINEAGES DURING THE MESOZOIC

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Keywords: phylogeny, Testudines, Cryptodira, Pleurodira, Mesozoic.

We developed a new global turtle matrix using morphological characters to test the age of the turtle crown and to assess the origin and phylogeny of various controversial clades along the stem and within the crown of Cryptodira (hide-neck turtles), including that of basal eucryptodires, softshell turtles, chelonioid sea turtles, and the extant big-headed turtle *Platysternon megacephalum*. We significantly increased both character and taxon sampling relative to earlier global matrices with special emphasis on Jurassic and Cretaceous stem-cryptodires. Further improvements included the complete, observation-based re-scoring of all previously added taxa and the reduction of subjective character assignments with the help of consensus-building between the members of our working group for each scoring.

We confirm the previous conclusion that the turtle crown has an extensive phylogenetic stem and that the age of the crown is approximately Middle Jurassic. The stem of crown turtles included some markedly bizarre forms, including the large-sized, terrestrial cow-horned turtles (Meiolanidae) which survived in Australasia until the age of early human settlements. The addition of new fossils allowed the recognition of Mesozoic meiolaniforms from mainland Asia, notably outside their previously known Gondwanan range. A global distribution is therefore apparent for Meiolaniformes in the Jurassic and was followed by the successive phylogenetic and biogeographic splits into Asian, South American, and Australian clades in synchrony with the break-up of Pangea.

The inclusion of a broad sample of stem-cryptodires allowed a better estimate of character polarity and of evolutionary relationships within crown-cryptodires. We found little or no support for the snapping-turtle (Chelydridae) affinities of the big-headed turtle, *Platysternon megacephalum*, otherwise inferred by previous morphological analyses; in conspicuous contrast with molecular results. Similarly, little support remains for a Trionychia-Kinosternoidea (softshell-musk turtle) clade, which had been consistently recovered in earlier morphological studies, again in contrast with molecular phylogenies. Contrary to previous hypotheses, our analysis advocates sea turtle monophyly and argue for a diverse Cretaceous stem of the extant leatherback turtle lineage (Dermochelyidae), including bizarre, giant forms belonging to the extinct clade Protostegidae. Oddly enough, derived members of Protostegidae show remarkable parallels with true leatherbacks as a result of convergent evolution.

Despite increased taxon and character sampling, we were still unable to fully replicate the molecular phylogeny of turtles. This is especially frustrating because the stratigraphic distribution of taxa is more consistent with molecular results. The likely reason for this disparity partly comes from the high degree of homoplasy in turtles and the rapid and early diversification of extant turtle lineages soon after the appearance of the turtle crown. The latter is also suggested by the overall good support at the end of the branches and low resolution at the nodes connecting their stem. Future fossil discoveries, particularly from the Jurassic of South and Southeast Asia, will likely help resolve these issues.

RECORD OF THE OLD WORLD RUMINANT DIVERSIFICATION SEQUENCE AND EXPLANATIONS FOR DISPARITY HISTORY FROM NEONTOLOGY

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Keywords: *spatiotemporal species diversity dynamics, digestive morphophysiology, reproductive biology, key innovations, increased fitness.*

Old world ruminants constitute a substantial component of the Neogene and Quaternary continental fossil record. As revealed from their vast spatiotemporal distribution and many remarkable sedimentary sequences, there is a diversification sequence which shows significant disparity among the different families through time. In order to quantify these dynamics and find explanations we explored data on fossil species diversity and extant species biology. We found that tragulid and giraffid diversity first increased during the Early/Middle Miocene with subsequent declines, whereas bovid and cervid diversity increased distinctively. This is in amazing coincidence with the existence of the omasum (third stomach compartment) in living pecoran ruminants (which is absent in tragulids), shorter gestation periods in living non-giraffid pecorans (as opposed to giraffids) and occupied niches or species diversity respectively. We infer that these could represent cases of key innovations that caused dynamics in diversity patterns in Old World ruminants. Since literature suggests that the different ruminant groups inhabited similar niche spectra at different times, our resulting narrative, combining digestive morphophysiology, reproductive biology and the fossil record, thus supports the 'increased fitness' interpretation, where a key innovation does not mainly open new niches, but allows more efficient use of existing ones.

NEW FOSSIL MAMMALS FROM THE NORTHERN NEOTROPICS (URUMACO, VENEZUELA; CASTILLETES, COLOMBIA) AND THEIR SIGNIFICANCE FOR THE LATITUDINAL GRADIENT IN DIVERSITY AND THE GREAT AMERICAN BIOTIC INTERCHANGE

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Keywords: *Notoungulata, Rodentia, Xenarthra, biogeography, Neogene.*

The Great American Biotic Interchange (GABI) refers to the faunal exchange between North and South America around the time of closure of the Central American Seaway, an event that modified the mammal fauna of both continents. Unfortunately, given the scarce of knowledge from Neotropical fossil sites, current hypotheses about diversity dynamics during this migration event have been based on data from temperate sites. The same geographic bias exists when examining the latitudinal taxonomic diversity gradient in South America and its evolutionary roots in the Cenozoic.

We present new data from the Urumaco sequence in Venezuela and from new sites at the Guajira Peninsula, northeastern Colombia, which together comprise a sequence of faunas expanding from the early Miocene to the early Pliocene. These faunas, due to their age and geographical location, serve to characterize the northern Neotropical mammal community before and after GABI's migrational intervals. Studies of several taxonomic groups involve different teams of researchers.

In Urumaco the greatest diversity of mammals is in the xenarthrans, with at least 20 species representing Mylodontids, Megalonychids, Megatherines, Glyptodontids, Pamphaterids and Dasypodids from the Socorro, Urumaco, Codore and San Gregorio formations. Different species provide insights into the re-ingression from North America, taxonomic affinities with megalonychids otherwise present in the Caribbean islands, and the record in these northern latitudes of 'basal' forms recorded in earlier deposits of higher latitudes of the continent.

Among rodents, claims of larger diversity in Urumaco have not been substantiated by any descriptive reports. The revision of both new dental and postcranial remains and their variation revealed that several species, at least four, must have existed, including *Phoberomys pattersoni*, *Eumegamys* sp., and *Neoepilema* sp. The rodents from Castilletes include undetermined gigantic forms and Hydrochoeridae.

Among the 'meridiungulata', cranial remains of toxodonts suggest the presence of forms with plesiomorphic features unexpected for animals at this geological age. Astrapotheres include cranial remains from Castilletes representing the oldest record of Uruguaytheriinae in the tropics, whereas materials from the Urumaco sequence are postcranials and suggest a different locomotory style that the southern taxa from which postcrania is known.

The oldest procyonid carnivores from the northern neotropics are recorded based on dental remains, from Castilletes and Urumaco (San Gregorio Fm.), both of affinities with genera recorded so far from Argentina. Other novelties from these faunas are cranial and postcranial remains of cetaceans.

We complement field data by compiling and analyzing the composition of late Neogene mammal assemblages in the Americas by computing the percentage of both native and migrational faunas across a latitudinal gradient. Migrations started in the late Miocene (~10 Ma), but most exchange occurred after the early Pliocene (~5 Ma). In tropical South America migrants are first recorded in the Pliocene, whereas in temperate South America there are some records of North American migrants during the late Miocene and Pliocene, but is not until the Pleistocene when migrants became common.

UNRAVELING THE MYSTERY OF DIGGING ADAPTATION OF *MESOSCALOPS MONTANENSIS* BY MEANS OF GEOMETRIC MORPHOMETRICS AND FINITE ELEMENT ANALYSIS

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Keywords: *Talpoidea*, *geometric morphometrics*, *Finite Elements Analysis*, *comparative methods*.

The extinct Talpoidea clade Proscalopidae show one of the most modified humeral morphologies among mammals. It has been suggested in the past that *Mesoscalops montanensis*, one of the best-known proscalopids from the Early Miocene of Wyoming (USA), had a unique mode of digging in comparison to both extant and extinct talpids. Differently from other burrowing mammals the digging movement was achieved by using a different set of main muscles (in particular the M. Teres major and M. Infraspinatus). It has been also suggested that the functionally closest extant group is the clade Chrysochloridae from Central-Southern Africa. In fact, African moles show a scratch-digging burrowing movement involving mainly the M. Latissimus dorsi and M. Triceps. In contrast, Talpidae show a typical humeral-rotating movement accomplished by the intensive action of M. Teres major and M. Pectoralis pars sternalis. Here we combined 2D shape analysis and 3D structural Finite Element Analysis in order to unveil the particular functional adaptation of *M. montanensis*. 3D models of humeri were built for 18 taxa using CT scans including *M. montanensis* and the whole morphological diversity of Talpidae and Chrysochloridae: *Talpa romana*, *T. tyrrhenica*, *Mogera wogura*, *M. tokudae*, *M. imaizumii*, *M. insularis*, *Parascalops breweri*, *Proscapanus sansaniensis*, *Urotrichus talpoides*, *Desmana moschata*, *D. pontica*, *Galemys pyrenaicus*, *Asthenoscapter meini*, *Chrysochloris asiatica*, *C. sthulmanni*, *Eremitalpa granti* and *Calcochloris obtusirostris*. Geometries were imported in Comsol Multiphysics and a 3d elasticity problem was solved. In particular, three different boundary conditions were set on the humerus depending on the different musculoskeletal configurations occurring in Talpidae, Chrysochloridae and *M. montanensis*. For Talpidae we placed anatomical constraints in correspondence of the humeral head and the clavicular articular facet, while for *M. montanensis* and Chrysochloridae instead, we just used the humeral head, as in these taxa the clavicle articulates only with the scapula and not with the humerus. The loads were placed in correspondence of insertions of the three above-mentioned muscular configurations. All models were scaled to the same size and the same force reaction was set in correspondence of the ulnohumeral joint. Von Mises stress was calculated over the whole volume and compared with 2D Geometric Morphometrics data taken on the same models. We found that the structural behaviour of *M. montanensis* is close to that of *C. sthulmanni* and *C. asiatica* as previously hypothesized on the basis of qualitative observations. The Talpinae clade experienced the least structural stress while Desmaninae, Uropsilinae and Urotrichinae showed the most stressed morphologies. We also found that, on the phylogeny, the phenotypic evolutionary rate of Von Mises stress underwent a neat deceleration in correspondence of the Talpinae clade.

THE MIDDLE PLEISTOCENE *MACACA SYLVANUS* FOSSIL RECORD FROM CENTRAL ITALY

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Keywords: Middle Pleistocene, Primates, Italy, taxonomy.

During the Plio-Pleistocene the Barbary macaque *Macaca sylvanus* was widely distributed throughout Europe. European fossil macaques are usually considered as belonging to the *M. sylvanus* lineage, but there is some uncertainty regarding their specific taxonomic status. Three subspecies are classically recognised in the fossil record of continental Europe: the Pliocene *M. sylvanus prisca* Gervais, 1859; the Late Pliocene to Early Pleistocene *M. sylvanus florentina* Cocchi, 1872; and the Middle to Late Pleistocene *M. sylvanus pliocena* Owen, 1846. The Plio-Pleistocene fossil record from the Italian peninsula includes cranio-mandibular fragments, isolated teeth or fragmentary postcranial bones. The best preserved and complete material comes from the Late Pliocene site of Villafranca D'Asti (Piedmont), and from the Early Pleistocene sites of Upper Valdarno (Tuscany) and Pietrafitta (Umbria). The Middle Pleistocene fossil record is documented in central Italy and in particular in Latium, where the Barbary macaque is recorded in the Roma area (Polledrara di Cecanibbio, and Torre in Pietra - around 0.3 ma - Casal Selce, around 0.6 ma, and Monte Sacro), and in the Frosinone area (Cava Pompei and Fontana Ranuccio, Anagni basin, around 0.4 ma).

NEW PHYLOGENETIC INSIGHTS INTO EUROPEAN ANTHRACOTHERES (ARTIODACTYLA, MAMMALIA)

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Keywords: Anthracotherium, Europe, Oligocene, biostratigraphy, phylogeny.

Anthracotheres ("Anthracotheriidae", Hippopotamoidea, Artiodactyla, Mammalia) lived almost worldwide from the Late Eocene to the Early Pliocene, migrating early from Southeast Asia, firstly towards North America, then towards Europe and Africa (Lihoreau and Ducrocq, 2007). The members of this family were adapted to many different ecologies and successfully colonised various habitats throughout their evolutionary history. The genus *Anthracotherium*, along with many other mammals, arrived in Europe during the migration events linked to the Grande Coupure (MP21-22; Hooker et al., 2004) and became extinct on this continent by the end of the Oligocene (e.g., Scherler et al., 2013).

Cuvier (1822) described first the remains of the "charcoal beast" *Anthracotherium*, creating its type species *A. magnum* from the Italian locality of Cadibona and the smaller *A. alsaticum* from the French site of Lobsann. Since then, no less than fifteen species were identified, sometimes solely based on a few remains recorded in a unique locality, varying from sizes, dental morphologies, and geographic regions (e.g., *A. hippoïdeum* Rüttimeyer, 1857, *A. valdense* Kowalevsky, 1976, *A. seckbachense* Kinkel, 1884).

A thorough review of the European anthracotheriines made on fossils from old collections of diverse Natural History Museums allowed us to highlight important variations in the dental morphology of the different species. Based on a cladistic analysis, we suggest to split in two the representatives of European "*Anthracotherium*" and propose a diagnosis for a new genus. This new phylogeny challenges the old vision of the subfamily's evolutionary history in Europe.

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THE MIOCENE CROCODYLIAN FAUNA OF VENEZUELA – NEW INSIGHTS INTO CRANIAL ANATOMY AND TAXONOMIC COMPOSITION

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Keywords: *Crocodylia*, *Archosauria*, *Urumaco Formation*, *osteology*, *Thecachampsa*.

The Upper Miocene Urumaco Formation as exposed in the badlands close to Urumaco town in Falcón State, Venezuela, yields a highly diverse crocodylian fauna. It has been previously proposed that 14 taxa are present in the formation of which in some localities at least seven species occurred sympatrically (Scheyer et al., 2013). The presence of some species however requires testing in a small number of localities, because they are based on a few specimens, which are incomplete or insufficiently preserved to reveal diagnostic features. During a fieldtrip to the Miocene and Pliocene outcrops of the in fall 2014, collections in Venezuela (in Caracas, Coro and Urumaco) have thus been visited to re-study the crocodylian type material and to compare it also with new fossil findings in the collections.

In this endeavor, the high crocodylian diversity, as well as the outstanding level of sympatry in the Urumaco Fm. could be corroborated (including a new locality north of El Picache, which again yielded high numbers of fossil crocodylian species). In contrast, some specimens in the collections which previously had been identified down to species level (e.g., specimens identified as belonging to *Caiman brevirostris*) are revealed to be recognizable only to the generic or family levels instead. The differences in the naso-frontal contact between *Caiman brevirostris* and *Globidentosuchus brachyrostris* could be confirmed, however, although this feature is often obscured by the preservational artifacts such as gypsum crusts or an almost complete substitution (as a form of pseudomorphosis) of the bone matrix by gypsum.

The first detailed osteological study of specimens previously identified as the crocodyloid *Thecachampsa* spp. in the collections in Urumaco town, and its comparison to other materials belonging to gavialoid species stored in the different collections, indicates that these materials have to be reassigned to Gavialoidea, with close affinities to *Ikanogavialis* and *Gryposuchus*. The recently described crocodylid *Crocodylus falconensis* from the Pliocene San Gregorio Formation (Scheyer et al., 2013) thus seems to be the first true representative of Crocodyloidea in Venezuela. The configuration of the skull roof of the holotype of *Mourasuchus arendsi* as given by Boquentin (1984) was further found to be erroneous, and a new reinterpretation of the suture pattern is in accordance with that seen in the skull of *Mourasuchus nativus* Gasparini, 1985, arguing for potential synonymy of both species.

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DINOSAURS FROM THE NETHERLANDS: THE TYPE MAASTRICHTIAN

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Keywords: *Dinosaurs, Maastrichtian, Maastricht, The Netherlands, Cretaceous.*

Non-avian dinosaur fossils from the shallow-marine strata of the type Maastrichtian (SE Netherlands, NE Belgium; Jagt et al., 2012) are extraordinarily rare, and to date, discoveries have been mostly limited to isolated, severely damaged bone and tooth fragments (Mulder, 1984; Mulder et al., 1997; Weishampel et al., 1999; Jagt et al., 2003; Mulder et al., 2005; Buffetaut, 2009; Jagt et al., 2012). In some two and a half centuries of intensive collecting effort by amateurs and professionals alike, all in all just over two dozen fragments of dinosaur bones and teeth have been recovered. With the exception of a single partial theropod femur, all other identifiable elements have been attributed to hadrosaurs. In this contribution we present a brief review of the material recorded to date. In addition to the dinosaur remains, the terrestrial fossil vertebrate record at the moment also comprises a single mammal tooth (Martin et al., 2005) and a handful of bird remains (Dyke et al., 2002, 2010).

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THE FORGOTTEN CROCODILIANS FROM MONTE BOLCA: REVISION OF THE TURIN SPECIMEN ORIGINALLY REFERRED TO *CROCODILUS VICETINUS* LIOY, 1856

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Keywords: *Allognathosuchus*, *Hassiacosuchus*, *Eocene*.

The crocodylians from the Eocene Monte Bolca are known since XIX century when Paolo Lioy (1856) described a well preserved specimen as the new species *Crocodylus vicetinus* Lioy, 1856 (now considered invalid and referred to *Asiatosuchus* Mook, 1940; see Kotsakis et al., 2004). Subsequently, many other fossils from this locality were described by Sacco (1896), who identified some as *C. vicetinus*, but also erected the new taxon *Crocodylus bolcensis* Sacco, 1896 (a species now referred to the genus *Pristichampsus* Gervais, 1853, or *Boverisuchus* Kuhn, 1938; see Brochu, 2013). The purpose of this work is to revise the systematic position of the specimen MGPT-PU 17329, hosted in the collections of the Museo di Geologia e Paleontologia of the Torino University, which are currently part of the Museo Regionale di Scienze Naturali. The specimen consists in a partially preserved skeleton embedded in a limestone slab. It is represented by the skull and lower jaw, the hindlimbs and the forelimbs, the cervical and caudal vertebrae, and few scattered bones. The rest of the skeletal elements is missing or deformed by the oxidation of the pyrite (special care should be applied to this specimen in future in order to avoid further degradation). MGPT-PU17329 was initially referred to *C. vicetinus* by Sacco (1896), but Berg (1966) identified it as *Allognathosuchus haupti* (Weitzel, 1935) on the basis of a similar shape of the dentary (with marked waves), of the teeth (the posterior teeth are blunt) and of the posterior margin of the skull. According to Brochu (2004), *Allognathosuchus* is probably non monophyletic and different genera can be identified on the basis of the relationship between the length of the prefrontal and lacrimal. Because *Allognathosuchus haupti* from Germany shows a lacrimal longer than the prefrontal, Brochu (2004) recommended to place it in the genus *Hassiacosuchus* Weitzel, 1935. Following this new taxonomic arrangement, Kotsakis et al. (2004) referred MGPT-PU17329 to *Hassiacosuchus* sp. However, even if it is not possible to detect the sutures of the lacrimal and the prefrontal in MGPT-PU17329, and therefore the relative length of these two bones is unknown, strong evidence supports the assignment of this specimen to the German taxon. On the basis of our observations we tentatively refer it to *Hassiacosuchus* cf. *H. haupti* Weitzel, 1935. Due to the still unsettled taxonomy of the European Eocene alligatoroid related to *Allognathosuchus* s.l. (*Allognathosuchus gaudryi* Stefano, 1905, *Allognathosuchus gracilis* Rauhe and Rossmann, 1995, *Allognathosuchus woutersi* Buffetaut, 1985, and *Eocenosuchus weigelti* Kuhn, 1938), it is premature to propose any precise phylogenetic relationship and biogeographic context for MGPT-PU17329.

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BIOMECHANICAL CONSEQUENCES OF ROBUST CRANIOFACIAL FEATURES IN THE SARDINIAN FOSSIL OLD WORLD MONKEY

MACACA MAJORI

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Keywords: *Macaca majori*, craniofacial mechanics, warping, FEA.

The Sardinian fossil old world monkey *Macaca majori* exhibits a derived, robust craniofacial morphology. This robustness reflects craniofacial features that have evolved several times in diverse primate lineages including that of the australopiths. In particular *Macaca majori* presents a posterior broadening and anteroposterior shortening of the palate, an expanded post-canine dentition with inflated bunodont cusps, a zygoma and postorbital bar that are robust and flare laterally, and a prominent supraorbital torus (Szalay & Delson 1979; Rook & O'Higgins 2005). An important question that arises concerns the extent to which such features impact on craniofacial skeletal performance during acquisition and processing of food items. Further the question arises as to the specificity of impact on performance individual aspects of craniofacial form; do individual features confer benefits on their own or do they impact on performance in a more integrated way?

To these ends we compared skeletal performance during simulated M¹ biting between a reconstructed adult representative of *Macaca majori* (ty5199) and an adult representative of *M. fascicularis*. This comparison used finite element analysis (FEA) to predict strain magnitudes when biting. The differences in performance between these crania were then further investigated. These follow-on analyses applied FEA to investigate the effects of sequentially modifying aspects of facial morphology in *M. fascicularis* such that they took on the form of the same region in *M. majori*. The features were modified using thin plate splines to warp isolated anatomical regions from *M. majori* to *M. fascicularis*. This allowed us to investigate the biomechanical consequences of each aspect of modified morphology.

The results indicate that the *M. majori* face is more rigid under M¹ biting than that of *M. fascicularis*; exhibiting reduced strain energy densities (SED). Interestingly, finite element models that incorporate only one or some of the *M. majori* traits indicate that these traits influence SED both locally as well as in adjacent and more distant regions, and that these effects are not simply additive. Thus, morphological modifications affect facial biomechanics in complex and unexpected ways. The possibility that local morphological changes may have global biomechanical effects implies that craniofacial features related to feeding biomechanics have evolved in an integrated fashion. We infer that the derived facial traits of *M. majori* may be adaptations for reducing stress in the facial skeleton during feeding. An implication of our study is that derived facial traits in australopiths that resemble those in *M. majori* may also be biomechanically significant and may be adaptations for ingesting or masticating resistant foods. Our approach has wide applications to a variety of biomechanical questions, and our findings have important consequences for assessing character independence in cladistic and functional analyses.

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RECONSTRUCTION OF THE SKELETON OF *TEILHARDINA BELGICA*, THE OLDEST EUROPEAN PRIMATE

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Keywords: *Omomyidae*, Tienen Formation, MP7, Dormaal, Belgium.

Teilhardina belgica is one of the earliest fossil primates ever recovered and the oldest fossil primate from Europe (~ 56 Million years). It was originally described by Teilhard de Chardin (1927) from the MP7 reference level of Dormaal (Belgium), which is situated at the Paleocene-Eocene boundary at the base of the Tienen Formation (Smith & Smith, 1996).

Teilhardina is known on all three northern continents in association with the carbon isotope excursion marking the Paleocene–Eocene Thermal Maximum. Relative position within the carbon isotope excursion indicates that Asian *Teilhardina asiatica* is oldest, European *T. belgica* is younger, and North American *T. brandti* and *T. americana* are, successively, youngest. Analysis of morphological dental characteristics of all four species supports an Asian origin and a westward Asia-to-Europe-to-North America dispersal for *Teilhardina*. High-resolution isotope stratigraphy indicates that this dispersal happened in an interval of 25,000 years (Smith et al, 2006).

Moreover, *Teilhardina* is one of the most primitive fossil primates known to date and the earliest haplorhine with associated three dimensional postcranials making it relevant to a reconstruction of the ancestral primate morphotype. As such, *Teilhardina* has often been hypothesized as a basal tarsiiform on the basis of its primitive dental formula with four premolars and a simplified molar cusp pattern. Until recently, little was known concerning its postcranial anatomy with the exception of its well-known tarsals. Here we describe additional postcranial elements for *Teilhardina belgica* and compare these to other tarsiiforms and to primitive adapiforms. *Teilhardina* is a small primate with an estimated body mass between 30-60 g, similar to the size of a mouse lemur. Its hindlimb anatomy suggests frequent and forceful leaping with excellent foot mobility and grasping capabilities. It can now be established that it exhibits critical primate postcranial synapomorphies such as a grasping hallux and a tall knee (Gebo et al, 2012), and nailed digits (Rose et al, 2011). This anatomical pattern and behavioral profile is similar to what has been inferred before for other omomyids and adapiforms. The most unusual feature of *Teilhardina belgica* is its elongated middle phalanges suggesting that this early primate had very long fingers similar to those of living tarsiers. Our phyletic analysis indicates that we can identify several postcranial characteristics shared in common for stem primates as well as note several derived postcranial characters for Tarsiiformes.

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A NEW HYAINAILOURINE FROM BARTONIAN OF EUROPE

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Keywords: *Hyaeodontida, Hyainailourinae, Africa, Europe, Eocene.*

One of us (D. Vidalenc) discovered during the 1980's a skull, two hemimandibles and several hind limb elements (fibula, astragalus, calcaneum, metatarsal, and phalanges) from the Bartonian (MP 16) localities of Lautrec and Montespieu (Tarn, France). These fossils can be referred to a new species of Hyainailourinae, a subfamily of the specialized carnivorous hyaeodontidans. The new species, of which the skull is roughly 35 cm long, may have weighted 140 kg and was the largest carnivorous mammal in Europe at that time. Beside its very large size, the new taxon shows an interesting combination of very primitive (presence of large p1 and P1) and derived features (very secant molars).

The new taxon possesses a very primitive masticatory apparatus among hyaeodontidans. The skull morphology, which reflects a very powerful bite force, is common in hyainailourines. It demonstrates that the hyainailourines were already adapted to a particular ecology, which could be close to that of extant hyenas. This brown bear-sized hyainailourine thus could have been a scavenger. The postcranial elements, which are rare for the hyainailourines, indicate a plantigrade stance and a terrestrial locomotion.

Its size and the presence of derived dental features were unexpected for a hyainailourine of this age. Its discovery thus illustrates an unexpected diversity of the Hyainailourinae during the Bartonian.

Because the hyainailourines first appeared in Africa (Solé *et al.*, 2013), the new taxon migrated into Europe during the Bartonian, probably together with the hyainailourine *Paroxyaena*. However, because the two taxa are not at the origin of Priabonian hyainailourines from Europe, we hypothesize that the hyainailourines dispersed twice into Europe during the Eocene: (1) during the Bartonian (*Paroxyaena* and the new species) and (2) during the Priabonian (*Parapterodon* and *Pterodon*). These migrants have had no equivalent in Europe at this time and probably did not conflict with the endemic carnivorous mammals, the hyaeodontidan proviverrines.

We performed the first phylogenetic analysis of the hyainailourines to determine the relationships of the new taxon and to understand the evolution of hyainailourines. The new taxon shows that the large body size appears early in the evolution of hyainailourines. However, the largest hyainailourines – *Hyainailouros* and *Sivapterodon* date from Miocene and may have weighted almost 800 kg – interestingly radiated along with small-sized hyainailourines (below 15 kg). This shows that hyainailourines occupied different ecomorphospaces in Africa.

Finally, the study of the skull of the hyainailourines supports a close relationship between the Hyainailourinae and Apterodontinae, which also originated and radiated in Africa. We thus propose to group the two subfamilies in a new clade: Hyainailouromorpha.

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THE CHINESE EUPARKERIIDS AND A MONOPHYLETIC EUPARKERIIDAE

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Keywords: Euparkeria, Halazhaisuchus, Wangisuchus, Archosauriformes, Triassic.

The stem archosaur *Euparkeria capensis* from the Anisian of South Africa is placed as the sister taxon to crown Archosauria or Archosauria+Phytosauria in most phylogenetic analyses. This taxon is thus of great importance in our understanding of the archosaur radiation following the Permian-Triassic extinction event and the evolution of crown Archosauria. Several species have been referred to the family Euparkeriidae, but the monophyly of this putative clade has largely remained untested. Three Chinese taxa – *Halazhaisuchus qiaoensis*, '*Turfanosuchus* *shageduensis*', and *Wangisuchus tzeyii*, all from the early Middle Triassic Ermaying Formation of northeast China – have been suggested recently to be euparkeriids. We reassess the taxonomy of these taxa and place them for the first time in a numerical cladistic analysis. We find no morphological features to distinguish '*Turfanosuchus* *shageduensis*' and *Halazhaisuchus qiaoensis* and they are found as sister taxa in our phylogenetic analysis; we thus regard '*Turfanosuchus* *shageduensis*' as a subjective junior synonym of *Halazhaisuchus qiaoensis*. *Halazhaisuchus qiaoensis* is recovered as the sister taxon to *Euparkeria capensis* (with this clade in turn the sister taxon to Archosauria+Phytosauria), and thus a monophyletic Euparkeriidae composed of these two taxa is supported. This provides the first quantitative support for a monophyletic and polyspecific Euparkeriidae. This support is however weak, and based primarily on osteoderm characters. The holotype material of *Wangisuchus tzeyii* is undiagnostic and there is no satisfactory evidence that material referred to the taxon pertains to the same taxon as the holotype. We thus regard *Wangisuchus tzeyii* as a *nomen dubium*.

GENOME SIZE AND OSTEOCYTE LACUNA SIZE IN RECENT AND FOSSIL SALAMANDERS

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Keywords: *genome size, salamanders, Lissamphibia, osteocyte lacuna, bone histology.*

Modern salamanders possess giant genomes compared to all other known tetrapods. Despite any salamander genome being too big for complete sequencing, recent studies have shown that they have large introns and novel genes (Smith et al. 2009). Salamander large genome size may be closely associated with the option to retain a neotenic lifestyle as well as their capacity to entirely regenerate limbs, eyes, spinal chord and other complex tissues. It has been suggested that salamanders had large genomes at least since the origin of crown group salamanders (Smith et al. 2009), in the Middle Jurassic ± 165 Ma (Gao and Shubin 2003). To explore the precise origin of the large genome sizes of salamanders, we have sectioned long bones ($N > 18$, mostly femora) of members of all modern salamander families with known genome sizes as well as long bones of members of several fossil amphibian lineages. Understanding the correlation between osteocyte lacuna size and genome size in modern taxa is vital to investigate the genome sizes in fossil taxa. Where previous osteocyte lacuna-genome size studies failed to recognize the importance of sample location and orientation, we aimed to sample homologous elements in the same location and the same plane of sectioning. Our results indicate that large genomes were already present in stem-group salamanders (Karauridae) and most likely can be traced back to the late Paleozoic dissorophoid temnospondyls. The measurement of genome sizes in salamanders, their supposed fossil relatives as well as other extinct amphibians not only provides a strong phylogenetic character to trace back the origin of modern lissamphibians, but it also helps us in understanding large scale evolutionary processes on a genomic scale.

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POSTCRANIAL OSTEOLOGY OF A NEW SPECIMEN OF THE CAIMANINE *PURUSSAURUS* FROM THE NEOGENE OF VENEZUELA

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Keywords: *Crocodylia*, *Alligatoroidea*, *Caimaninae*, *Purussaurus*, *anatomy*.

Comparing the extant crocodylian diversity of 23 species worldwide which has at maximum three sympatric living species with the crocodylian fauna during the late Miocene in South America reveals outstanding differences: 5 Million year ago, there existed 14 species in South America and seven sympatric crocodylian species were found in some localities in Urumaco (Scheyer et al. 2013). This region reveals a unique crocodylian fauna with coexisting members of *Alligatoroidea* and *Gavialoidea*. A new specimen (AMU-CURS-541) which is preliminarily identified as belonging to the giant genus *Purussaurus* was found, including an exceptional quantity of postcranial material. It was found in November 2013 during a student field trip organized by the Palaeontological Institute and Museum, University of Zurich. The specimen contains cranial remains, vertebrae from the neck region (atlas, axis and cervicals) up to the caudal region, well preserved elements of the pectoral and pelvic girdles, as well as elements of the appendicular skeleton, ribs and over 50 osteoderms.

Several studies about the crocodylians from the Neogene of Venezuela were based mostly on skulls and there was no special focus on the postcranial skeleton, due to the scarcity of postcranial remains (e.g., Brochu and Rincón, 2004; Aguilera et al., 2006; Riff and Aguilera, 2008). For the anatomical description of the new specimen, other crocodylian taxa from the collections in Urumaco and Coro (AMU-CURS and UNEFM-CIAPP) are used for comparison. The preliminary analysis of AMU-CURS-541 shows that 11 out of 19 postcranial characters listed in Brochu (2011) can be scored, especially from the neck region. Given the length of the preserved lower jaw and the size of the vertebrae preserved, the new specimen is estimated to range around 8-10 metres in total length.

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MICROHYRAX LAVOCATI, A DIMINUTIVE HYRACOID FROM THE EOCENE OF ALGERIA AND TUNISIA, AND THE EARLY RADIATION OF THE ORDER HYRACOIDEA (MAMMALIA, AFROTHERIA)

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Keywords: Hyracoidea, phylogeny, Paleogene, Africa.

Hyracoids are poorly diversified today, with only three small-sized genera restricted to Africa and the Middle East. In contrast, during the Paleogene they represented the dominant 'ungulate' group on the Afro-Arabian continent. Among the rare early Paleogene sites from that continent, those from the Gour Lazib area in Algeria yielded the earliest diverse hyracoid assemblage, dated from the late Ypresian or basal Lutetian. These sites particularly point out the ancient diversity of hyracoids in having yielded at least seven contemporaneous species showing a large range of body-mass and different dental morphologies that indicate several dietary specializations ranging from omnivory to folivory (Tabuce et al. 2011). *Microhyrax lavocati* is the smallest species of this hyracoid assemblage, its estimated body mass is ca. 3 kg (Schwartz et al. 1995). Up to now, only three specimens of *Microhyrax* have been described: the holotype (a lower jaw with p3-m3) (Sudre 1979), a possible upper M3 (Tabuce et al. 2001), and a maxillary fragment with M1-3 (Tabuce et al. 2007). Phylogenetic reconstructions suggest that *Microhyrax* is one of the earliest offshoot of the hyracoid order (e.g. Barrow et al. 2012).

Recent paleontological fieldwork in the Gour Lazib area (including the Glib Zegdou outlier) but also at Chambi in Tunisia has led to the recovery of numerous new specimens of *Microhyrax* allowing a reassessment of this critical basal hyracoid. The new material includes isolated deciduous and permanent teeth, fragmentary dentaries, maxillaries, isolated petrosals, as well as two partial skulls. These specimens properly document, for the first time, the upper dentition of *Microhyrax*. Actually, the maxillary and upper molar published by Tabuce et al. (2001, 2007) are now attributed to *Helioseus*, another more specialized hyracoid of the fauna. These new data are essential because they reveal that in all recent cladistic analysis, discussing the relationships of stem hyracoids and afrotherians as a whole, *Microhyrax* is thus wrongly coded as a chimera. As a result, the current well-accepted basal position of *Microhyrax* within the phylogenetic tree of hyracoids needs to be reconsidered.

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NEW DATA ON BIOGEOGRAPHY AND EVOLUTION OF RHYNCHOSAURS

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Keywords: *Rhynchosauria, Norian, Rhaetian, Triassic, Europe.*

Rhynchosaurs are a group of herbivorous basal archosauromorphs. Their jaws with beak and tooth-plates were adapted to rough plant material. Hind limbs with large claws and characteristic morphology of pelvis were designed for digging. They were one of the main components of many Middle and early Late Triassic terrestrial ecosystems. Their fossils were found in numerous localities in Americas, Africa and India. These suggest that rhynchosaurs had wide geographical range across Pangea. Limits of this ambit remain unknown due to poor sampling in southern- and northern-most parts of Pangea (Australia and Antarctica from one side and Eurasia from the other side of the globe). In Europe, the rhynchosaur record is restricted to the Otter Sandstone and Lossiemouth Sandstone (Anisian-Ladinian and Carnian) from the Great Britain. Here we communicate about two new localities (Woźniki and Lisowice) with fossils of these archosauromorphs from the Upper Triassic of Poland. This exceeds their range to Central Europe. What is more, it was postulated that rhynchosaurs became extinct with the end of the Carnian. The new findings from the Lower-Middle Norian of Americas falsified this hypothesis. Rhynchosaur from Lisowice is dated as latest Norian or early Rhaetian, thus they prolong further the range of the entire group. This new form resembles *Hyperodapedon gordonii* from the Carnian of England. The distinct funnel-like groove on acetabular wall of this new rhynchosaur species is interpreted as a place for the femoral ligaments. Probably this lineage was improving its digging abilities.

**A REVISION OF *XINJIANGCHELYS OSHANENSIS* (YE, 1973), AND
NEW MATERIAL FROM THE MIDDLE JURASSIC OF LUFENG,
YUNNAN PROVINCE, CHINA**

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Xinjiangchelys oshanensis (Ye, 1973) was originally described as *Plesiochelys oshanensis* Ye, 1973 from the Jurassic Upper Lufeng Series of Eshan, Yunnan Province, China. The species was based on a single specimen (IVPP V4444), a damaged shell with articulated carapace and plastron (Ye, 1973). This species was later referred to *Xinjiangchelys? oshanensis* and *X. oshanensis* respectively; but has never been revised and often overlooked in the studies of Asian Mesozoic turtles. We provide the systematic revision of *X. oshanensis* (Ye, 1973). Five additional shells from the Middle Jurassic Chuanjie Formation of Lufeng, Yunnan Province, China are referred to this species. Our study confirms the validity of the species and its assignment to the genus *Xinjiangchelys*. The study of the new material completes the shell morphology of *X. oshanensis* and provides the additional information about the age of that taxon.

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AT CLOSE RANGE: MICROMAMMAL BIOGEOGRAPHY OF THE MIDDLE/LATE MIOCENE WITHIN THE IBERIAN PENINSULA

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Keywords: *micromammals, Iberian Peninsula, Vallesian Crisis, Late Miocene, biogeography.*

As classical Neogene sites in the Vallès-Penedès have been re-opened, and new excavations in the area yielded a wealth of data, the 'Vallesian Crisis' has again become a hot topic of debate in the last couple of years. Originally considered a local event within the Vallès-Penedès, the notion of a major faunal change during the early Late Miocene has been considered to be a continent wide event by some. However, doubts have been cast on the extent and severity of this event.

Madern and van den Hoek Ostende (2012) noted that the biodiversity in the Vallès-Penedès in the MN unit preceding the Vallesian Turnover (MN 9) is considerably higher than in the inland basins. This is, in fact, considered common knowledge. Many mammals from the Catalan basin are not known from the inland, with the primates, purported victims of the Vallesian Crisis, as best known example.

Here, we present an analysis of the differences in micromammal composition between the coastal Vallès-Penedès and the inland Teruel Basin (including the Daroca Calamocha area) before and after the Vallesian Crisis. These basins are geographically close, at a distance of c. 300 km. We focus on micromammals since these have been well sampled in a dense stratigraphical record in both areas, incorporating data from the NOW database, supplemented with data from literature and recent additions. Our analyses cover the MN units 7+8-11 (late Aragonian to early Turolian).

It is evident that several groups from the coastal area never made it to the inlands, such as the flying squirrels and a large number of insectivores. Surprisingly, the diversity peaks in the two areas do not coincide. Whereas the largest diversity the Vallès-Penedès is found in MN 9 (just prior to the turnover) biodiversity peaks in the inland basins in MN 7+8. Moreover, the similarity between the coastal area and the inlands is lowest during MN 9, suggesting that the Vallès-Penedès at this time was indeed somewhat extraordinary. The large differences even at relatively short distances support the idea that the 'Vallesian Crisis' is at the most a local event.

ENTERS THE SHREW; DIACHRONICITY IN EUROPEAN INSECTIVORES (EULIPOTYPHILA, MAMMALIA)

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Keywords: *diachronicity, Eulipotyphla, Miocene, Europe, biogeography.*

Van der Meulen et al. (2011) underlined the diachronicity of mammal events comparing entries and extinction of rodents in well-studied sections from the North Alpine Foreland Basin (NAFB) and the Aragonian type section in Central Spain, which all have been correlated to the magnetic time-scale. Their conclusions had a major impact, particularly on the biochronological MN-system (De Bruijn et al. 1992), as it showed that MN units were to a certain degree diachronical. However, the second largest group of micromammals, the insectivores, was not included in their deliberations. Indeed, De Bruijn et al. (1992) still considered the group insufficiently known to be used in stratigraphic schemes. Much progress has been made in the taxonomy, and stratigraphy of Miocene Eulipotyphla in the last 25 years, and the group is now considered particularly useful for palaeoenvironmental reconstructions, and more specifically as a proxy for humidity (Furió et al., 2011), or even as biostratigraphic marker (e.g., Prieto et al. 2011).

We tested the ranges of the eulipotyphlans, based on the rodents as proposed in Van der Meulen et al. (2011). The pattern that arises within the insectivores shows three groups. (1) A number of taxa migrating to Spain in the early Middle Miocene appear earlier and expire later in the NAFB, their Central European range bracketing the Iberian ones (e.g., *Galerix symeondisi*, *Florinia*). This suggests a temporary range expansion into the peninsula when conditions were favourable, as shown for instance by the rodents (e.g., Oliver et al. 2013). *Desmanodon* was already present at the beginning of the Middle Miocene, but also expires earlier in Spain than in NAFB. However, younger occurrences in Europe seem to be related to a new wave of migration from the east. (2) Some taxa (*Amphechinus*, *Miosorex*, *Parasorex*) survive longer in Spain, which could indicate a retraction to the south. All of these taxa carry some taxonomical issues, but particularly the survival of *Miosorex* is in line with its presumed preference for warm habitats. (3) Two taxa show a very strong diachronicity. *Dinosorex* had entered Germany already prior to 17 My (Petersbuch 2), but has its first occurrence in the Vallès-Penedès (12 Ma). At the same time the basin holds FO of *Plesiodimylus* in Spain, not counting some transient occurrences in the Early Miocene. These records also mark the beginning of sedimentation in the region, so a somewhat older occurrence of these taxa cannot be discarded.

One of the most remarkable findings of Van der Meulen et al. (2011) was that the sequence of rodent events in different parts of Europe was virtually the same, even if the timing of individual events proved to be diachronous. The pattern emerging from the insectivore data is very different. Their ranges and migration events appear to be strongly environmentally controlled.

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GROWTH, DEVELOPMENT AND LOCOMOTION IN PLEISTOCENE DWARFED HIPPOPOTAMI

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Fossil insular mammalian dwarfs have variably been reported to show rapid ontogenetic development (Raia et al., 2003), slow development (Köhler et al., 2009), as well as truncation of growth (Bromage et al., 2002). These three modes of dwarfing have different implications for the life history of the animals under consideration and their morphological plasticity. The three modes of dwarfing have been recognised in different species, on different islands, using different methodologies. It may, thus, be hypothesised that different taxa show different responses to island environments, or that environmental differences are the cause for the different dwarfing modes. Alternatively, the difference may even be a methodological artefact. In addition, insular dwarfs have been described as being adapted to low-gear locomotion in their mountainous habitats.

The main objective of this study was to determine the mode of dwarfing in insular hippopotami and their locomotory adaptations. Bones and teeth of Pleistocene dwarfed hippopotami from Cyprus (*Phanourios minor*) and Crete (*Hippopotamus creutzburgi*), and their normal sized relatives, were μ CT-scanned and thin-sectioned. Three-dimensional microstructure was inferred from the scans, and the striae of Retzius periodicity, bone lacunae densities and lamellae counts served as proxies for development rate and time.

Microstructure analyses of the dwarfed hippopotami indicate that they were likely less aquatic than the common hippopotamus (*Hippopotamus amphibius*), which has been proposed to be ancestral to *P. minor*. Histological analyses indicate that juvenile dwarfed hippopotami had comparable growth rates to juveniles of the common hippopotamus, but truncated growth at an earlier absolute age. Adult dwarfed hippopotami were shown to display very high remodelling rates compared to the modern reference sample.

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ERUPTION PATTERNS AND DENTAL HISTOLOGY IN ARTIODACTYLS AS MARKERS OF POSTNATAL GROWTH AND LIFE HISTORY EVOLUTION

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Keywords: tooth eruption, cervids, *Megaloceros*, cementum analysis.

The sequence of dental eruption is diverse in non-random ways across mammalian species and phylogenetic patterns and life history correlates can be found. For example, the shifting of the time of eruption of replacement teeth in primates has been suggested as indicative of life span and speed of growth. The tendency to replace teeth early in species with fast growth and long life span is called the Schultz's 'rule'. In order to explore this hypothesis for another mammalian clade, we provide new dental eruption data for extant and extinct cervids and integrate these into a survey for the Artiodactyla. Examination in a phylogenetic context is of paramount importance to test for any life history correlations. The small sized *Capreolus capreolus* starts replacing the deciduous dentition after the second molar has emerged whereas the bigger sized cervid species such as *Dama dama* usually replace the first deciduous tooth already before this event.

Additionally to the study of the tooth eruption patterns dental histology was used for attaining individual ages. Examination of rest lines in lower first molar tooth cementum can be useful to estimate longevity, as demonstrated here for several extinct and extant cervids, including the giant deer *Megaloceros giganteus* and the dwarf island cervids *Candiacervus ropalophorus* and *Candiacervus* spp. II. Rest lines in tooth cementum are more reliable than those in the bone cortex, because of bone remodeling and resorption processes throughout an individual's life. However, a survey across 'ungulates' indicates that larger forms tend to exhibit more clear growth marks than small sized ones. Maximum longevity estimates indicate 18 years for late Pleistocene dwarf *Candiacervus* and 19 years for *Megaloceros giganteus*. Therefore, in an allometric context *Megaloceros* was short-lived when body mass is taken into account.

MORPHOLOGICAL DISPARITY OF THE POSTCRANIAL SKELETON IN RODENTS: THE CASE OF THE EXTINCT THERIDOMYIDAE (RODENTIA, MAMMALIA).

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Keywords: postcranial skeleton, rodents, Theridomyidae, disparity, locomotion.

Today, rodents represent roughly half of the mammalian diversity. Among them, the extinct theridomyids were the most diverse and abundant rodents in Western Europe during a period spanning from the Late Eocene to the Late Oligocene. Interestingly, this province was almost entirely (Late Eocene) or partly (Oligocene) isolated from other landmasses. In this context, their evolution remained mainly insular, leading to an increase of evolutionary rates. If theridomyids are most often known from isolated teeth, postcranial material is also available but has so far attracted less attention. As a few partial or subcomplete skeletons of theridomyids (*Suevosciurus*, *Issiodoromys* and *Theridomys*) were previously described (Lartet 1869, Lavocat 1951, 1955, Schmidt-Kittler & Storch 1985), it was then possible to identify isolated postcranial elements of issiodoromyines (*Blainvillimys* and *Pseudoltinomys*) in four localities from the Quercy region situated in South of France (Belgarric1, MP25a; Mas-de-pauffié & St-Privat-des-Vieux, MP26; Pech-Desse, MP28a) and from the classical locality Ronzon (Puy-de-Dome, MP21). Until recently, it was commonly considered that theridomyids were generally engaged in a form of active quadrupedal locomotion including frequent leaping activity in their locomotor repertoire. This type of locomotion was primarily based on the previous studies of postcranial remains of *Issiodoromys*.

Combining statistical approaches (size parameters and ratios, factorial discriminant analyses; e.g. Candela & Picasso, 2008; Samuels & Valkenburgh, 2008) with comparative functional anatomy, we show that theridomyids exhibited a wider range of activities and positional behaviours characterizing distinct types of locomotion. Despite the limited number of taxa for which postcranial data are available, at least four types of locomotion can be identified : 1- the quadrupedal possibly semi-fossorial *Suevosciurus*, 2- the occasionally bipedal ricochetal *Issiodoromys*, 3- the scansorial *Theridomys bonduelli*, and 4- the cursorial *Blainvillimys*. This work will be published in the book *Evolution of the Rodents: Advances in Phylogenetics, Functional Morphology and Development* edited by Cambridge University Press (Cambridge).

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EARLY PLEISTOCENE HERPETOFAUNA FROM TEGELEN (THE NETHERLANDS)

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Keywords: Tiglian, palaeobiogeography, *Mauremys*, *Palaeobatrachidae*.

Preliminary identifications (Hoek Ostende & Vos 2006) have pointed out a significant diversity in the herpetofauna from the Tiglian (early Pleistocene) of Tegelen (Province of Limburg, The Netherlands), but a complete study of the remains of amphibians and reptiles from this locality has never been made. A more exhaustive analysis on >1500 skeletal elements has confirmed the presence of previously recognized taxa, but also yielded new ones. Based on the new identifications, fossil amphibians from Tegelen consist of *Triturus* gr. *T. cristatus*, *Lissotriton* sp., *Pelobates fuscus*, *Bufo bufo*, *Bombina* sp., *Pelophylax* sp., *Rana* sp., *Hyla* sp. and *Palaeobatrachus* sp., whereas reptiles are presented by *Lacerta* sp., cf. *Podarcis* sp., *Anguis* gr. *A. fragilis*, *Natrix natrix*, undeterminate Colubrinae, *Vipera* sp. and *Mauremys* sp. This collection comes from the infilling which also yielded the micromammal remains (Freudenthal et al. 1976) and is considered to represent the warm period TC5 in an otherwise relatively cool Tiglian.

This herpetofauna hosts mostly extant taxa but also a member of the extinct genus *Palaeobatrachus*. The presence of a palaeobatrachid in the early Pleistocene of The Netherlands is of great significance for the palaeobiogeography of this extinct family of anurans, since it was thought that it had disappeared from western Europe by the Miocene/Pliocene boundary (while it survived up to middle Pleistocene in the eastern part; Wuttke et al. 2012). Finding a still undeterminate species at Tegelen points out that at the beginning of Quaternary *Palaeobatrachus* was still present west to the Rhine Graben, at least with a relict population, possibly because of particularly favourable climatic conditions.

With one exception, the extant taxa from Tegelen have currently a broad latitudinal distribution. Remains of the European pond turtle, *Emys orbicularis*, have been reported for Tegelen by Schreuder (1946) and following authors, but the only identifiable turtle remain within the material we have studied, a fragmentary nuchal, is not attributable to this species and can be identified as *Mauremys* sp.

With the exception of some recently introduced populations of *Mauremys leprosa*, the present and Pleistocene-Holocene occurrences of this genus in Europe are limited to some Mediterranean countries and to the coast of Caspian Sea (Böhme & Ilg 2003; Sillero et al. 2014). The occurrence of *Mauremys* suggests that the climate during TC5 was potentially warmer than indicated by the rest of the herpetofauna.

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A REVISION OF THE CHELONIAN FAUNA FROM ALLATINI (THESSALONIKI, MACEDONIA, GREECE, LATEST MIOCENE- EARLIEST PLIOCENE)

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Keywords: Testudo amiatae, Mauremys, giant tortoises.

The clay deposits of Allatini (Pylaia or Capundjar; near Thessaloniki, Greece) were once famous for the excellent quality of clay, now fully exploited or covered by domestic areas. During the works in the clay pits many fossils referred to latest Miocene-earliest Pliocene (Trilophos formation, Western Chalkidiki deposits) were recovered. Among these findings, tortoise remains are the most notable. The first reference to them was made by Del Campana (1917, 1919), who described a shell attributed to *Testudo amiatae*, a non-hinged species previously described in the late Miocene of Italy by Pantanelli (1893), and a clutch of eggs of a giant tortoise. An additional specimen of *T. amiatae* from the same locality was described by Bachmayer & Symeonidis (1970). We revised both the old collections (Museo di Geologia e Paleontologia dell'Università di Firenze –Italy– and Museum of Geology and Paleontology, National and Kapodistrian University of Athens –Greece) and new material (Museum of Geology and Paleontology, Aristotle University of Thessaloniki –Greece). According to our results, the small testudinid from Allatini should not be associated with *T. amiatae*, due to the probable presence of a hypo-xiphiplastral hinge, which is a character of the *Testudo* sensu stricto lineage. Moreover, a new finding of a freshwater turtle from the same locality, preliminary identified here as *Mauremys* sp., shows that the chelonian fauna of Allatini was much more diverse than previously thought. The association of a small tortoise, a freshwater turtle, and a giant form is not common in the Greek fossil record, having been recorded only in the Early Villafranchian locality of Milia (Grevena, W. Macedonia, Greece; Vlachos, 2014). The revision of the *Testudo* from Allatini and the comparison with similar forms from South Balkans and Italy provides valuable information about the systematic position of the Late Neogene specimens of *Testudo* sensu stricto.

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BIRDS FROM THE LATE MIOCENE OF NORTHERN KAZAKHSTAN

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Keywords: *Late Miocene, Northern Kazakhstan, bird fauna.*

The famous Late Miocene (MN 12-13) locality Pavlodar in Northern Kazakhstan has yielded one of the richest “Hipparion faunas” in Asia. Mammalian remains from this locality have been extensively studied; they reveal a specific fauna with limited similarities to either European or other Asian (Mongolian and Chinese) contemporary communities. The mammal fauna includes open landscape inhabitants and documents the presence of semi-desert vegetation and extremely arid climate (Zykin, 2012). In contrast to mammals, birds from this locality are very poorly known. Kurochkin (1985) reported several taxa: an ostrich (*Struthio* sp.), a falcon (*Sushkinia pliocaena*), a partridge (*Palaeoperdix* sp.), an extinct two-toed crane (*Urmiornis* sp.), and a pipit (*Anthus* sp.). Furthermore, he described a new species of pipit, *Anthus seductus*, which definitively requires revision. Bones referred to *A. seductus* definitively belong to several different taxa. We have revised the previously known material and have studied new materials from this locality, which include remains of pipits, larks, starlings, buntings and a few remains of non-passerines birds. It is notable that the avian fauna from Pavlodar is different from the roughly contemporary fauna from Hyargas-Nuur 2 locality in Western Mongolia. A good number of passeriform remains in Pavlodar for the first time allows reconstruction of the evolution of perching bird communities in Inner Asia during the latest Miocene.

RODENT ASSEMBLAGES FROM SERBIA AROUND THE “GRANDE COUPURE”

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Keywords: Serbia, Paleogene, Rodentia, biostratigraphy, paleobiogeography.

New Late Eocene/Early Oligocene small mammal sites have been discovered in south east Serbia during field campaigns by members of the Natural History Museum of Beograd and the Department of Earth Sciences of Utrecht University in 2010-2013. Preliminary identification of the rodents from these sites shows that these are quite diverse and contain a large number of new species. The Paleogene assemblages from Serbia are dominated by Muridae, which is in sharp contrast to the contemporary theridomyid-dominated ones from western Europe. *Eucricetodon* (*Atavocricetodon*), a common member in many Eurasian fauna's, is absent in Serbia, and so are representatives of the Eomyidae, Sciuridae and Gliridae. The presence of an array of Pseudocricetontinae, Paracricetodontinae and Melissiodontinae suggests that we are dealing with hitherto unknown rodent associations that developed on a Dinaro/Balkanian micro-continent.

The peculiar composition of these Paleogene rodent associations hampers a straightforward correlation with successions from elsewhere. However, associations with a somewhat similar composition are known from the Lesser Caucasus and Baluchistan. The occurrence in Serbia of a representative of the Diatomyidae, a family that has so far been considered to be endemic to south east Asia, in the Early Oligocene assemblages suggests that this family may have a different area of origin than previously assumed.

The new faunas are of great interest for a better understanding of the distribution and evolution of the Muridae around the “Grande Coupure” as well as for reconstructing the paleogeography of the Balkans.

MACROEVOLUTIONARY PATTERNS OF MORPHOLOGICAL DIVERSITY: INSIGHTS FROM AN ONTOGENETIC PERSPECTIVE

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A central goal of evolutionary studies is to identify and understand the processes behind the observed non-random patterning of phenotypic space. The quantitative expression of traits that are coupled over the course of development, or to achieve a certain function, can be extracted as genetic (G matrix) or phenotypic (P matrix) covariances, providing an empirical and theoretical framework to examine how phenotypic spaces are patterned. Developmental insights into morphospace structuring have recently enabled an appreciation of the factors that influence the evolution of development on a macroevolutionary scale providing a promising avenue to address fundamental issues such as why development has evolved along a specific route, and how that may be generalized to explain observed morphological diversity. Rodents are unparalleled among mammals in terms of taxonomic success, and exhibit phenomenal levels of morphological diversity as well as a rich fossil record. These features provide a wealth of opportunities to explore phylogenetic, ecology or functional hypotheses relating to morphospace occupation. Using a combined approach to investigate the magnitude and patterning of ontogenetic evolution in rodents, I present macroevolutionary data on postnatal growth of the cranium in hystricognaths, muroids and sciurids (N=51 species). I analysed finite element models to detail 3D ontogenetic biomechanics (stress and strain magnitude and distribution) as well as allometric growth patterns and suture closure sequence patterns. These interrelated studies permit testing of the role of ecology in morphospace occupation in rodents, and provide insight into the importance of allometry, heterochrony and morphological trait correlations in generating morphological diversity. Results provide support for ontogenetic evolution in rodents having an adaptive base, and ecology is presented as a key factor underpinning trait interactions through ontogeny. Ontogenetic biomechanic models that detail stress and strain patterns in the cranium provide novel, quantitative data on so far unstudied trait correlations induced by the interrelationship between muscle and bone during growth. These new data yield important information for advancing the understanding of morphological trait variation, which is typically studied only at the adult stage.

THE *OREOPITHECUS BAMBOLII* ENAMEL-DENTINE JUNCTION (EDJ). EVIDENCE FOR EVOLUTION IN ISOLATION IN A LATE MIOCENE APE

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Keywords: *Oreopithecus* teeth, inner structural morphology, phylogenetic relationships, Synchrotron X-ray microtomography.

Oreopithecus bambolii survived isolated in the Tusco-Sardinian archipelago in the Late Miocene, until ca. 6.7 Ma (Rook et al., 2011). Its dentition, a blend of hominoid and cercopithecoid-like features, has been a matter of discussion since its first description in 1872, notably with reference to the phylogenetic issue. While the height and sharpness of its molar cusps recall some Cercopithecidae, *Oreopithecus*, likely related to dryopithecids, does not show a truly bilophodont condition; on the other hand, the development of a centroconid and the modification of the mesial fovea also distinguish it from penecontemporary hominoids (Harrison & Rook, 1997). An alternative approach to descriptive external morphology for the assessment of *Oreopithecus* adaptive and evolutionary status relies upon the characterization of its subtle inner structural dental variation, notably at the level of the enamel-dentine junction (EDJ). Three *Oreopithecus* lower permanent molars (LM1, LM2, LM3) from the site of Fiume Santo, in Sardinia, were detailed at 45.5 µm voxel resolution by synchrotron radiation microtomography (SR-µCT) at the ID 17 beamline of the ESRF of Grenoble (see Zanolli et al., 2010). In addition to classical morphological comparative descriptions of the inner structure, 3D geometric morphometric analyses of the EDJ (3DGMA) were performed on the *Oreopithecus* molars and compared to fossil (*Dryopithecus*, *Ouranopithecus*) and extant hominoids (*Homo*, *Pan*, *Gorilla*, *Pongo*, *Hylobates*), as well as to recent cercopithecoids (*Papio*). The 3D virtual modelling of the *Oreopithecus* tooth virtual record shows a high degree of morphostructural correspondence between the outer enamel and EDJ surfaces. More sharply imprinted at the EDJ level, some features are shared with fossil and extant hominoids (e.g., the trigonid crest pattern), others are autapomorphic traits (presence of well-developed hypolophid, hypometacristid, oblique crest and centroconid). On the other hand, *Oreopithecus* EDJ is clearly distinct from the typical condition of *Papio*. The 3DGMA results discriminate the high dentine horns and strait EDJ conformation of *Oreopithecus* and *Papio* molars from those of all fossil and extant hominoids (including *Dryopithecus*), while the respective position of the distal cusps allows the clear separation of *Oreopithecus* EDJ shape from the cercopithecoid condition. Overall, our results distinguish the morphostructural organization of *Oreopithecus* EDJ from that of *Dryopithecus* and *Ouranopithecus*, but also from the condition typical of extant hominoids and cercopithecoids, an evidence likely resulting from its later evolution in isolation. For scientific collaboration we thank the ESRF ID17 beamline, the Centre of Microtomographie of the University of Poitiers, L. Trebini from the Soprintendenza per i Beni Archeologici per le province di Sassari e Nuoro, Italy, and N. Mémoire from the Museum of Natural History of Bordeaux, France.

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TOOTH ENDOSTRUCTURAL CHARACTERIZATION AND TAXONOMIC ASSESSMENT OF THE MIOCENE HOMINOIDS FROM THE VALLÈS-PENEDÈS BASIN

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Keywords: fossil apes, paleobiodiversity, dental morphology, inner structure, X-ray microtomography.

Fossil hominoid discoveries in the Vallès-Penedès Basin during the last decade have led to the contention that four different genera (*Pierolapithecus*, *Anoiapithecus*, *Dryopithecus* and *Hispanopithecus*) are recorded there from Middle to Late Miocene (ca. 12.3 to 9.5 Ma) (Alba, 2012). These genera are distinguished mostly based on cranial morphology and, to a lesser extent, some dental features, but their taxonomic distinctiveness has been disputed. To further explore their tooth structural characteristics and possible diagnostic features, here we rely on 3D analyses based on high-resolution X-ray microtomography, with emphasis on relative enamel thickness (3DRET) and topographic distribution, as well as on the qualitative and quantitative morphological characterization of the enamel-dentine junction (EDJ).

MicroCT scans of 46 teeth were performed at The 'Abdus Salam' International Centre for Theoretical Physics (Trieste, Italy), and 41 of them were processed with a standard semi-automatic, threshold-based segmentation protocol. Besides computation of the 3DRET index (see Olejniczak et al., 2008), 3D geometric morphometric analyses (3DGMA) were conducted on the EDJ of 24 upper molars (e.g., Zanolli and Mazurier, 2013).

Our 3DRET results show that *Dryopithecus fontani* and *Hispanopithecus crusafonti* display a thin to intermediate-thin condition, whereas *Anoiapithecus brevirostris* is intermediate-thin, *Pierolapithecus cataulanicus* is intermediate-thin to thick, and *Hispanopithecus laietanus* ranges from a thin to an intermediate-thick condition (Fortuny et al., 2014). Regarding the EDJ morphology, the analyses reveal several subtle differences between the investigated taxa, including the morphology of the dentine horns (more peripherally situated and protruding in *D. fontani*), the mesial fovea, the trigon basin and the crista obliqua, among other features. 3DGMA of the EDJ show a good level of discrimination between *Dryopithecus*, *Pierolapithecus* and *Hispanopithecus*, while *Anoiapithecus* is intermediate between the two latter genera (especially for *H. crusafonti*). The two *Hispanopithecus* species (*H. crusafonti* and *H. laietanus*), even if slightly overlapping, exhibit distinct global EDJ shapes.

Overall, the results reported here refine and extend to Late Miocene taxa our previous 2D-based RET analyses (Alba et al., 2010) and, most importantly, also provide additional evidence on inner tooth structural morphology of the EDJ, supporting a taxonomic distinction at genus and species ranks among the Miocene apes represented in the Vallès-Penedès Basin.

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A LONG SUCCESSIVE OLIGOCENE SEQUENCE - REVISITING OF SAINT JACQUES, INNER MONGOLIA

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Keywords: Oligocene, mammals, faunal assemblages, terrestrial sequence.

Oligocene is a critical transitional period in the evolutionary history of Cenozoic mammals, and also witnessed one of the most severe climatic changes. To understand the relationship of mammalian evolution in response to climatic changes needs both long sequence and rich fossils. However, such terrestrial sequences with rich fossil records are rarely reported in the Eurasian continent.

Here we present the preliminary restudy at the traditional Chinese Oligocene locality—Saint Jacques, Ordos, China, which was first discovered by Teilhard de Chardin in 1923. The Saint Jacques fauna was originally recognized as Pliocene and later transferred to Oligocene (Teilhard de Chardin, 1924a, b; 1926). Additional fossils were discovered by Wang Banyue and her colleagues in 1980s, suggested at least two different horizons in this area, of Early Oligocene and Late Oligocene in age.

Our reexploration in this locality and vicinity gully reveals well developed terrestrial sediments with a long composite section over 200m in thickness, produced very rich mammalian fossils from every level of total 13 lithologic beds. Faunal assemblages from these levels show successive evolutionary stages of many lineages and diversification during the time period of Oligocene. Concordant with the Mongolian Remodelling hypothesis (Meng and Mackenna, 1998), there found no materials of Mesonychia, Hapalodectidae, Brontotheriidae, Deperetellidae and Helaletidae etc. in our three field seasons with extensive exploration and excavation from the Oligocene sediments. The lowest level, possibly Eocene age, produced mainly perissodactyle remains and turtles. Above that, an assemblage similar to the Kekeamu fauna in Alxa, Inner Mongolia shows earliest Oligocene characters, represented mainly by early ctenodactylids, primitive zaptodids and lagomorphs etc. Later assemblages can then be compared with biozones A-C1 in the valley of lakes area, Mongolia (Daxner-Höck et al., 2010). At the upper part of the section, an assemblage similar to the Xiejia fauna was discovered with representative taxa, such as *Yindirtemys suni*, *Tachyoryctoides*, *Sinolagomys pachygnathus*, Large *Parasminthus* and *Plesiosminthus*. The highest level of the section produced *Sinolagomys ulunguensis*, *Amphechinus*, *Eomyodon* and *Tachyoryctoides* etc which may highly be Miocene in age. Hence we tentatively conclude that the Saint Jacques section covers the most complete fossil records of Oligocene in Asia. Future magnetostratigraphic work are waiting for the biochronology and further study.

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**PRELIMINARY OBSERVATIONS ON HINDLIMB MYOLOGY AND
SYNDESMOLOGY OF THE DODO (*RAPHUS CUCULLATUS*,
COLUMBIFORMES)**

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Keywords: *Mauritius, musculature, locomotion, reconstruction, hind limbs.*

Although many of the pigeons are arboreal birds, some of them spend most of the time on the ground. This was especially true for large ground-dwelling Dodo of Mauritius. The cursorial habit of this species must have influenced the morphology of its legs. Although a number of works had been dedicated to the peculiarities of morphology and locomotion of the extinct Mascarene bird, none of them have dealt with the reconstruction of muscular and ligament structures of its hind extremities. The only existing work in which mostly the intrinsic muscles of tarsometatarsus are treated is too old to be used in modern analysis (Strickland, Melville, 1848). As the part of limb directly contacting to the substrate, avian foot is of particular importance in understanding the locomotor adaptations. Any changes in locomotion would affect its morphology, muscular and ligament structure. Tarsometatarsus of the Dodo resembles those of other ground pigeon, although being stouter due to the bulk of *Raphus*. The form and position of muscles, originating on the tarsometatarsus can be reconstructed in details due to the well-pronounced relief. As in modern counterparts, the following muscles were present in Dodo: *m. flexor hallucis brevis*, *m. extensor hallucis longus*, *m. adductor digiti 2*, *m. abductor digiti 2*, *m. extensor proprius digiti 3*, *m. extensor proprius digiti 4*, *m. abductor digiti 4*. The presence of *m. lumbricalis* cannot be verified as it does not contact to the bones. The development of the mentioned muscles is typical for Columbidae, except for the larger size of *m. flexor hallucis brevis*. This muscle, supporting larger *m. flexor hallucis longus* in flexion of the hind toe, is better developed in birds with long hallux (Zinoviev, 2002). Dodos, despite their ground-dwelling habits and the lack of perching and grasping abilities, retain relatively hallux for the balance's sake. Obviously stronger muscle supply of hallux is necessary to aid in balancing of such a large bird.

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[last minute addition]

SPERM WHALE TEETH FROM THE LATE MIOCENE OF CESSANITI (SOUTHERN ITALY)

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Keywords: *Cetacea, Physeteroidea, Miocene, Cessaniti, Southern Italy.*

The succession of Cessaniti encompasses a transgressive (Tortonian) – regressive (Messinian) cycle. A rich fossil record come from the Unit 2 (according to the stratigraphy by Gramigna et al., 2008), made up by grey sandstones containing a fully marine fauna, with extremely abundant echinoids, abundant sirenians (*Metaxytherium serresii*; Carone & Domning, 2007, Carone et al., 2013) and rare continental mammals (Ferretti et al., 2003, Gramigna, 2008, Marra et al., 2011).

Nine sperm whale teeth coming from Unit 2 have been tentatively attributed to *Scaldicetus* sp. by Carone (2010), according to the several species often referred to this genus based even on a single tooth. However, recent studies evidenced the weak diagnostic significance of teeth and, when found isolated, they have generally been referred to indeterminate physeteroids (Bianucci & Landini, 2006). The same approach is here proposed to describe and determine the teeth from Cessaniti, which unlikely the common occurrences, were not isolated but originally associated to remains of one skull and/or mandible now unfortunately lost.

The teeth are robust and fusiform, from circular to elliptical in cross section, with a relatively short enamelled crown and open pulp cavity. The apical wear varies from weak to strong and the distal portion of the root is marked by weak occlusal wear facets due to the opposite teeth. The presence of enamel is a plesiomorphic character that permits to exclude the appurtenance of these teeth to the Physeteridae + Kogiidae crown group. The occlusal wear indicates that there were functional teeth both in lower and upper jaw, suggesting that this sperm whale had a raptorial feeding behavior. The open pulp cavity and the relatively reduced wear remind an immature animal. The size of the Cessaniti teeth is intermediated between the one of *Zygophyseter* and *Acrophyseter*, significantly smaller than *Livyatan*. Considering the body length estimations of *Zygophyseter* and *Acrophyseter*, we can speculate a moderately large size (ca 5 m) for the Cessaniti sperm whale. Such a predator could have fed on the small (ca 2.2 m) sirenian *Metaxytherium serresii*, whose remains frequently occur at Cessaniti. Tooth marks on sirenian ribs have been hitherto attributed to sharks (Sorice, 2010). The discovery of more complete specimens of this sperm whale from Cessaniti beds could better support these preliminary considerations.

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[last minute addition]

LIFE RESTORATIONS OF QUATERNARY MAMMALS OF SICILY (ITALY)

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Keywords: Quaternary, mammals, endemites, island paleobiogeography.

Quaternary mammals of Sicily are intriguing subjects for paleoartists thanks to the presence of endemic species. Dwarf elephants and large dormice are impressive when drawn together, however they were rarely represented. In the paper of Leith Adams (1870), Jemima Wedderburn proposed a reconstruction of the Maltese fauna also suitable for Sicily, including a dwarf hippopotamus, a giant dormouse, a giant swan, a giant tortoise and three elephants of different sizes. Endemic species were figured resembling living ones but in different scales and mixing species of different ages. Similar restorations, based on a scaling starting from affine living species persisted in later illustrations, often simplified for scientific or didactic purposes, as in Azzaroli (1990). Some reliable illustrations, based on morphological data, appeared in popular books, as in Attenborough (1987) and Lambert et al. (2001). Mammals belonging to different faunal units are often figured together, with the aim of compare their sizes.

Life restorations here presented are mainly addressed to reliable reconstruction based on morphometric studies. In absence of complete skeletons, the reconstruction starts from bones of comparable ontogenetic age, then an estimation of the volume of muscles and their attachment points is provided (Antòn, 2007). Quaternary mammals of Sicily have living relatives and comparison with these latter can give a more comprehensive picture on the shape of the body, as well as the type and colour of integument and the animal-environment interactions. Paleogeography, vegetation spectra and paleoecological interactions among vertebrates of Sicily are available in the scientific literature (Bonfiglio et al., 2002; Yll et al., 2006; Marra, 2013) and can be used to reconstruct environments and landscapes.

Life restorations are here focused on Middle Pleistocene of Sicily, when the island experienced two different geographic settings and two different faunal complexes of terrestrial vertebrates (Bonfiglio et al., 2002; Marra, 2013). During early Middle Pleistocene conditions of strong insularity and small area led to mammal faunas strongly impoverished in number of species as well as unbalanced in ecological composition, represented by species with marked endemic characters. In the late Middle Pleistocene Sicily was attaining its present-day geography and large mammal fauna was renewed and diversified, with less pronounced endemic character; some small mammals persisted from the previous fauna, some evolved in situ, some others newly come from mainland.

These deep changes in insular environment and fauna are very interesting for paleobiology as well as for paleoart.

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[last minute addition]

NEW FINDINGS OF *STEGOTETRABELODON SYRTICUS* FROM THE LATE MIOCENE OF CESSANITI, SOUTHERN ITALY

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Keywords: Late Miocene, Southern Italy, *Stegotetrabelodon*, Proboscidea, paleobiogeography.

One mandible and an associated lower tusk fragment of *Stegotetrabelodon syrticus*, a primitive elephantid firstly recorded at As Sahabi, Northern Libya (Petrocchi 1954), were recovered at the end of the 1990s, from late Miocene deposits exposed near Cessaniti (Ferretti et al., 2003). In recent years, further remains attributable to *S. syrticus* have been retrieved in the same stratigraphical unit (Unit 2, Gramigna et al., 2008), consisting of a molar fragment, two incomplete humeri, a partial femur and a metapodial.

Unit 2 is made up by gray sandstones containing a fully marine fauna, with extremely abundant echinoids, relatively abundant sirenians (*Metaxytherium serresii*, Carone and Domning, 2007) and less common continental mammals: *Bohlinia attica*, *Samotherium* cf. *boissieri*, a boselafine bovid, an hexaprotodontid hippopotamus and a rhino (Gramigna, 2008, Marra et al., 2011). Unit 2 represents the onset of marine conditions in a succession representing a transgressive (Tortonian) – regressive (Messinian) cycle (Gramigna, 2008, Marra et al., 2011).

The mandible found in the 1990s was attributed to *S. syrticus* based on the elongated and down-turned symphysis of the mandible, the number and structure of the molar plates, and the oval cross section and lamellar inner structure of the tusk. The molars show some plesiomorphic characters with respect to that referred to the type material of *S. syrticus* from As Sahabi (late Miocene, Northern Libya; Ferretti et al., 2003), which might suggest a slightly older age for the Italian material.

Among the newly recovered remains, only the partial molar could be definitively attributed to *S. syrticus*, while the remainder of the fossils, represented by postcranial isolated elements, are compatible with corresponding skeletal elements from Sahabi described by Petrocchi (1954) and referred to the same species.

No significant size difference is observed between the Cessaniti and Sahabi *Stegotetrabelodon* sample, further supporting the opinion that the Cessaniti fauna represent a fully continental, not-endemic biota, differently from the rest of the Tortonian terrestrial vertebrate assemblages from Italy. Moreover, the findings of Cessaniti represent the only record of this species out of the Afro-Arabian province (Ferretti et al., 2003; Ferretti, 2008).

At Cessaniti, the co-occurrence of a frankly Afro-Arabian species as *S. syrticus* and two giraffid taxa (*Bohlinia attica* and *Samotherium* cf. *boissieri*) typical for the Pikermian biome suggest the existence of a land connection between the Cessaniti area and North Africa during the Tortonian, as well as the evidence of a phase of expansion of the Pikermian Biome into the African continent.

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[last minute addition]

LATE MIOCENE GIRAFFIDAE (MAMMALIA, ARCTIODACTYLA) OF THE CESSANITI-ZUNGRI BASIN, SOUTHERN ITALY

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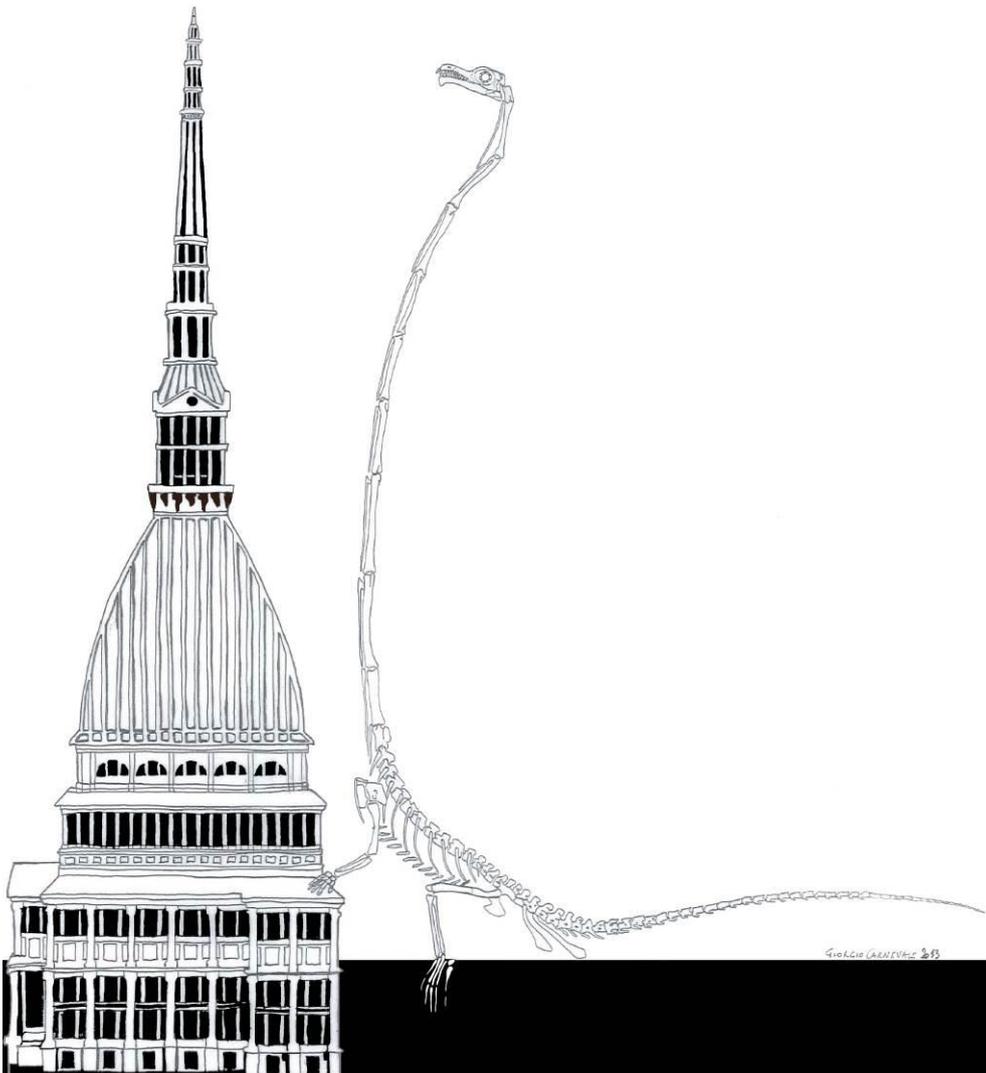
Keywords: Giraffidae, Late Miocene, Southern Italy, Pikermian biome, Paleobiogeography.

Giraffid remains attributed to *Bohlinia attica* and *Samotherium boissieri* have been recovered in the Cessaniti-Zungri basin, whose marine succession represents a transgressive (Tortonian) – regressive (Messinian) cycle. Fossils come from Unit 2 (gray sandstones; Gramigna et al., 2008) where a fully marine fauna, with extremely abundant echinoids, occurs with relatively abundant Sirenians (*Metaxytherium serresii*) and less common continental mammals including the mentioned giraffids, *Stegotetrabelodon syrticus*, a boselafine bovid, an hexaprotodontid hippopotamus and a rhino (Marra et al., 2011). *Bohlinia attica* is represented by a distal radius, two astragalii, two cubo-naviculars, and a distal tibia. All remains come from Gentile's quarry, near the village of Cessaniti. The astragalii show diagnostic features of *Bohlinia attica* (according to Geraads, 1994): bones are slender, with a neck wide and a *collum tali* massive in dorsal view; the plantar articular facet is uniformly convex and the posterior notch of the lateral throclea is elevated. The cubonaviculars have metatarsal facets separated by the *sulcus* for the long-peronian muscle, as in *Bohlinia*. A left upper tooth row (P3-M3) is tentatively attributed to *Bohlinia attica*. Teeth of *Bohlinia* are poorly known (Geraads et al., 2005) and are very similar in dimensions and morphology to *Palaeotragus* ones, except for the premolars P2 and P3 which are small and reduced in *Palaeotragus*. In the specimen from Cessaniti molars and premolars are brachyodont and large; the cingulum is evident on the labial side, and weak on the lingual side. Molars have a strong metastyle and a strong metacone rib, this latter as in *Bohlinia* (Gentry et al., 1999). P4 is as broad as M1. The parastyle of the premolars is large and bulky as observed in *Bohlinia* (Gentry et al., 1999). *Samotherium boissieri* remains come from Cessaniti (two metacarpals, two metatarsals, and a distal tibia) and from layers correlated to Unit 2 outcropping at Zungri (a complete left manus, a partially preserved left ulna, and a distal epiphysis of a left radius probably belonging to the same individual; humerus fragments, right carpal bones, a right metacarpal, and a distal right radius probably belonging to the same individual). The metacarpals have a semicircular proximal articular surface, the crests on the posterior rims of the diaphysis are not elevated, and the *sulcus* is shallow, as in *S. boissieri* (Solounias, 2007; Kostopoulos, 2009). The carpal bones from Zungri are the first record and description for this species, and are represented by a complete left manus and some carpal bones of a right manus (semilunar, pyramidal, uncinatum, pisiform). The metatarsals have a weak plantar crest in the shaft. Robusticity indexes of metacarpal and metatarsal are within the variability of *S. boissieri* from Samos (Kostopoulos, 2009). The occurrence of two giraffids typical for the Pikermian biome with *S. syrticus*, a frankly Afro-Arabic species, supports the hypothesis of a land connection between the Cessaniti-Zungri area and North Africa. Moreover, the occurrence of both giraffids evidences a phase of expansion of the Pikermian Biome into the African continent and then to Cessaniti-Zungri area.

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FIELD-TRIP GUIDE



THE MESSINIAN VERTEBRATES OF VERDUNO

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The first excursion of the XII EAVP Meeting will give the participants the opportunity to observe part of the the Messinian succession cropping out along the Tanaro River in the Verduno locality, (the Verduno section; Dela Pierre et al., 2011) (Fig. 1), and recording all the stages of paleoenvironmental evolution of the Messinian Salinity Crisis event. Fossil vertebrate remains relatively abundant in all the exposed units of the succession. Fossil fishes, primarily represented by well-preserved articulated skeletal remains of the cyprinodontid *Aphanius crassicaudus*, are very common in several of the euxinic shale intervals of the

Primary Lower Gypsum unit, together with frequent insect and plant remains. Moreover, the upper portion of the succession, corresponding to the Cassano Spinola Conglomerates Formation, has yielded very rich assemblages of continental vertebrates (Colombero et al., 2014). The stratigraphic setting of the succession and its paleontological content are described in the following sections. The paleontological material collected at Verduno, together with other fossil remains from other successions in the nearby are housed in the Museo Civico “F. Eusebio” of Alba, which will be also visited during the day.



Fig. 1. Aerial view of the Tanaro River between Verduno and Alba (province of Cuneo). The star indicates the location of the Messinian outcrops along the river.

GEOLOGICAL AND STRATIGRAPHIC SETTING

The Tertiary Piedmont Basin (Figs. 1A, B) is located on the inner side of the south-western Apennine arc and is filled with Upper Eocene to Messinian sediments deposited unconformably upon a wedge of Alpine, Ligurian and Adria basement units juxtaposed in response to the collision between the Europe and Adria plates (*e.g.* Mosca et al., 2009; Rossi et al., 2009). Messinian strata were deposited in a wide wedge top basin (Figs. 2B, 3A), bounded to the north by the more external Apennine thrusts (Rossi et al., 2009; Dela Pierre et al., 2011). The shallow marginal zones are presently exposed in the northern (Torino Hill and Monferrato) and southern (Langhe) sectors of the Tertiary Piedmont Basin, whereas the depocentral zones are buried below Pliocene and Quaternary sediments (Savigliano and Alessandria basins) (Fig. 2A).

The base of the succession consists of outer shelf to slope muddy sediments referred to as the Sant'Agata Fossili Marls (Tortonian-lower Messinian) recording progressively more restricted conditions heralding the onset of the Messinian Salinity Crisis (MSC; Sturani and Sampò, 1973). This unit displays a precession-related cyclic stacking pattern, evidenced by the rhythmic repetition of euxinic shale/marl couplets (Lozar et al., 2010; Violanti et al., 2013), and is followed at basin margin by the Primary Lower Gypsum unit (Roveri et al., 2008, in press) (Fig. 3A). The latter shows the same precession-driven lithologic cyclicity, represented by shale/gypsum couplets (Dela Pierre et al., 2011). *In situ* primary evaporites are not documented in the depocentral zones, but seismic data suggest that their time equivalent sediments are represented by shales (Irace et al., 2010).

The transition between the shallow marginal area and the buried depocentre is exposed on the southern sector of the Piedmont Basin (Alba region) and was reconstructed in detail along a SW-NE transect (Dela Pierre et al., 2011) (Fig.

3B). Along the margins of the basin, six Primary Lower Gypsum cycles were recognised, composed of bottom grown-selenite layers; the sixth bed represents a distinct marker bed referred to as the Sturani key-bed (Dela Pierre et al., 2011). Moving towards the NE (*i.e.* towards the depocentral zone), only two gypsum beds are present below this marker bed. In the Verduno section these overlie a cyclic succession of euxinic shales, marls and carbonate-rich beds, belonging to the Sant'Agata Fossili Marls Formation (Fig. 3B). Due to their position with respect to the Sturani key-bed, the uppermost three cycles must be considered as the deeper water equivalent of the lower cycles of the Primary Lower Gypsum unit deposited in marginal setting (Dela Pierre et al., 2011). This correlation is confirmed by bio-magnetostratigraphic data, indicating that the onset of the MSC should be placed at Verduno three cycles below the first gypsum bed, in correspondence of the peak abundance of the calcareous nannofossil *Sphenolithus abies* (Lozar et al., 2010). The carbonate layers were interpreted as the product of lithification of chemotrophic microbial mats dominated by sulphide-oxidizing bacteria (Dela Pierre et al., 2012).

The Primary Lower Gypsum unit is overlain by resedimented and chaotic evaporites (Valle Versa Chaotic Complex; Dela Pierre et al., 2007), which are considered to be equivalents of the Resedimented Lower Gypsum unit (Fig. 3B) deposited during the second MSC stage (5.60-5.55 Ma) (Roveri et al., 2008, in press). This latter unit is overlain by the fluvio-deltaic and lacustrine deposits of the Cassano Spinola Conglomerates Formation, recording the third MSC stage (5.55-5.33 Ma), in turn overlain by Zanclean marine clays (Argille Azzurre Formation).

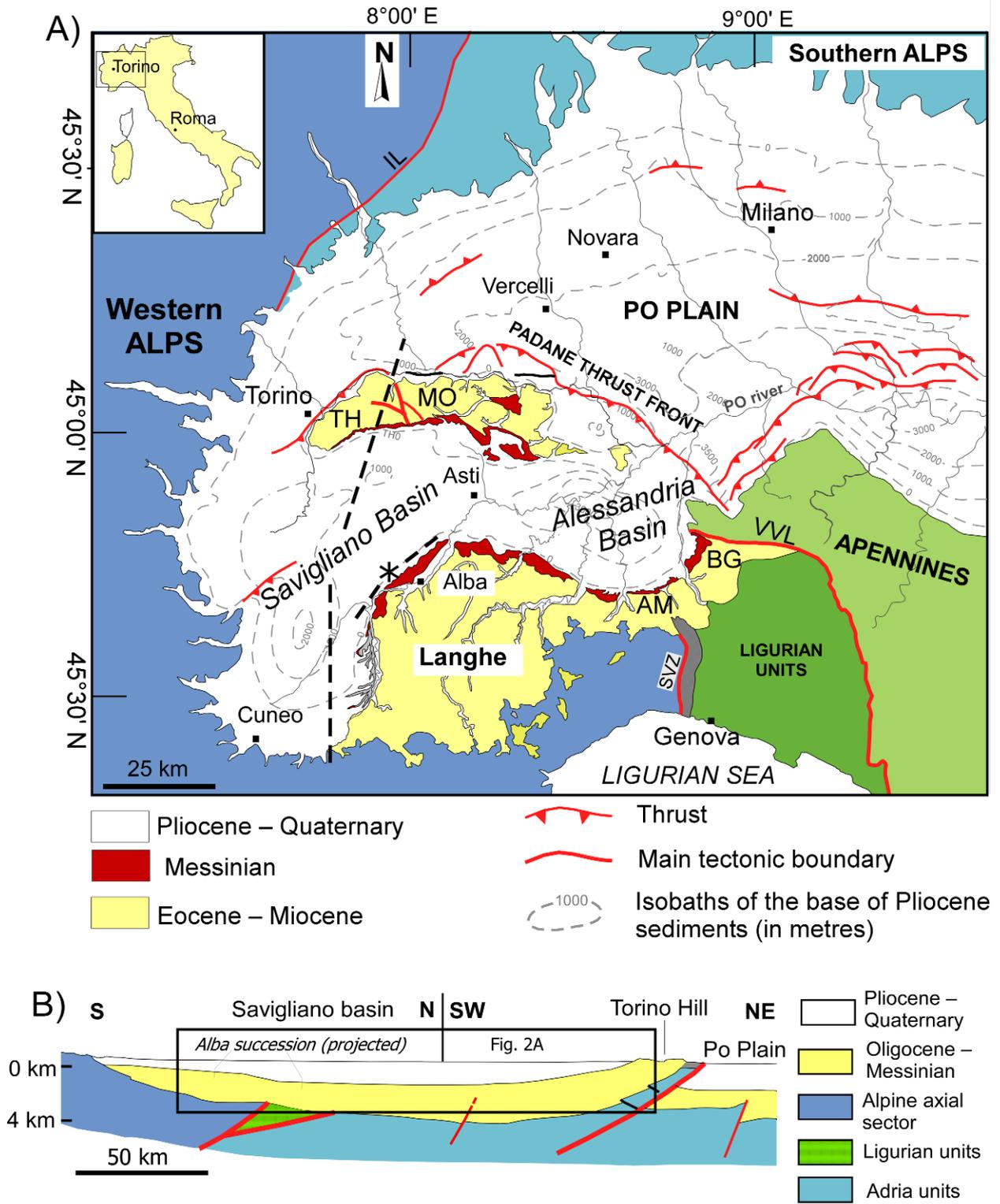


Fig. 2. A) Structural sketch of NW Italy (modified from Bigi et al., 1990). The asterisk indicates the location of the Verduno section. TH: Torino Hill; MO: Monferrato; AM: Alto Monferrato; BG: Borbera-Grue; VVL: Villalevernia-Varzi Line; SVZ: Sestri-Voltaggio zone; IL: Insubric Line. B) Regional section in a N-S direction (redrawn after Bertotti and Mosca, 2009; Mosca et al., 2009). Location in Fig. 2A.

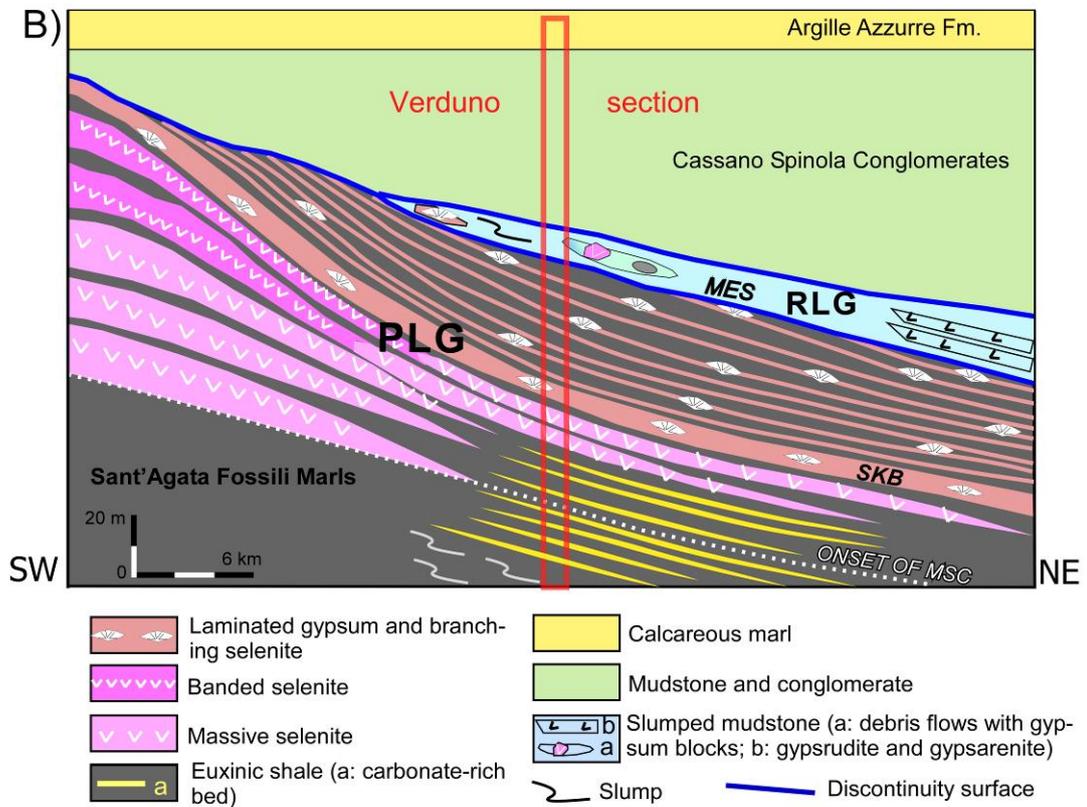
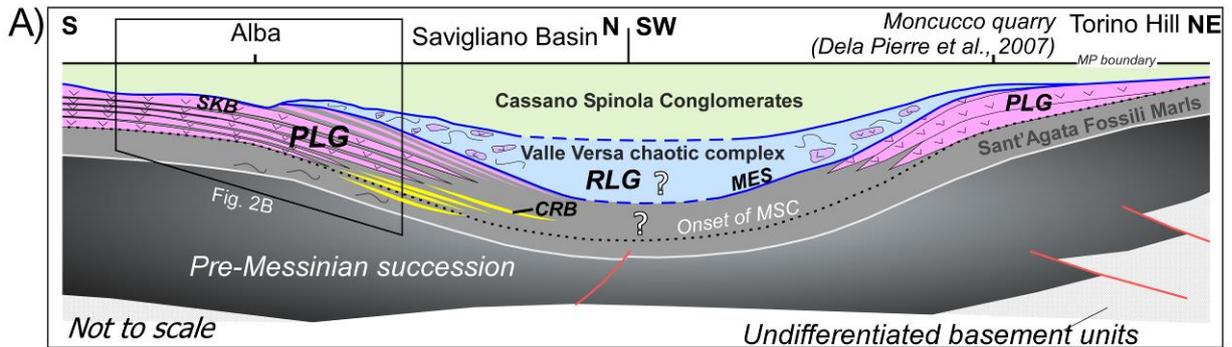


Fig. 3. A) Schematic cross section, flattened at the base of the Pliocene, showing the relationships among the Messinian units. PLG: Primary Lower Gypsum unit; RLG: Resedimented Lower Gypsum unit; MES: Messinian erosional surface; SKB: Sturani key-bed; CRB: carbonate-rich beds (from Dela Pierre et al, 2011). Not to scale. B) Stratigraphic model of the MSC record of Alba along a SW-NE cross section flattened at the base of the Pliocene. The location of the Verduno section is shown. The carbonate-rich beds discussed in the text are marked in yellow (from Dela Pierre et al., 2011).

The Verduno section

In this section, located along the Tanaro River, a complete Messinian succession, comprising the Sant'Agata Fossili Marls Formation, the Primary Lower Gypsum and the Resedimented Lower Gypsum units, and the Cassano Spinola Conglomerates Formation, is exposed (Fig. 4).

Sant'Agata Fossili Marls Formation (SAF)

The upper part of SAF is exposed at Verduno for about 130 m. A 80 m thick slumped interval allows to divide the section into two parts.

The lower part, below the slump, shows a distinct sedimentary cyclicity. The basic cycle, about 4 m thick, consists of laminated euxinic shales and homogeneous bioturbated calcareous marls. Fossil content of marly beds consists of foraminiferans, calcareous nannofossils, bivalves (*Propeamussium* sp. and *Cuspidaria* sp.), nassarids gastropods, pteropods (*Cavolinia* sp., *Clio* sp., *Limacina* spp.), and land plant debris. In euxinic layers, partially complete articulated skeletons of epi- and mesopelagic fishes, (*Alosa elongata*; *Myctophum* sp.) have been found (e.g. Gaudant and Cavallo, 2008). These cycles are overlain by the slumped interval, in which beds are extensively folded.

Above the slump, the cyclic organization of the sediments is more clearly visible (Fig. 5). In particular, seven cycles (Pm1 to Pm7, Fig. 4) are recognised from the top of the slump up to the base of the overlying Primary Lower Gypsum unit (PLG). The cyclicity is expressed by regular fluctuations of the carbonate content of the sediments. The basic cycle, about 3 m thick, is composed of laminated euxinic shales, transitionally overlain by homogeneous marls that are in turn followed by a 10-15 cm thick carbonate cemented bed (layers c, d, e in Fig. 4) and by an upper layer of marls. As discussed above, the upper three cycles (Pm5 to Pm7, Fig. 4) must be considered as the lateral deep water equivalent of the lower three PLG cycles (Dela

Pierre et al., 2012; Violanti et al., 2013). The sharp peak of abundance of the calcareous nannofossil *Sphenolithus abies*, recorded at the base of Cycle Pm5 (Fig. 4) reflects a paleoceanographic event slightly preceding the final disruption of the water column and is correlatable with several sections in the Mediterranean region (Manzi et al., 2007). According to Lozar et al. (2010) and Violanti et al., (2013), this event approximates the onset of the MSC in the Verduno section that is thus located about 9 m below the first gypsum bed belonging to the Primary Lower Gypsum unit. Remarkably, the carbonate layers belonging to these cycles are thinly laminated and show abundant filaments interpreted as *Beggiatoa*-like bacteria. These beds are interpreted as microbialites, resulting from the lithification of chemotrophic bacterial mats dominated by sulphide-oxidizing bacteria, and developed on dysaerobic sea bottoms (Dela Pierre et al., 2012).

Primary Lower Gypsum unit (PLG)

The basal portion of this unit consists of two cycles (Pg1 and Pg2, Fig. 4) of laminated muddy siltstones followed by massive selenite beds about 1-m thick (Fig. 6A); according to Dela Pierre et al. (2011), these cycles correspond to the 4th and 5th cycles of the Primary Lower Gypsum unit, respectively. They are followed by the Sturani key-bed (SKB) corresponding to the 6th PLG cycle (Fig. 6B). This bed, about 7 m thick consists of a regular alternation of mm-thick clayey/carbonate and gypsum-rich laminae (Fig 6C). Gypsum laminae are composed by tiny (10-20 µm) elongated single crystals or twins. Gypsum crystals are enclosed in a clayey matrix and do not show any preferred orientation but are rather randomly distributed on the lamina surface. Within the clayey-rich laminae, gypsum crystals are less abundant and scattered within the terrigenous sediments.

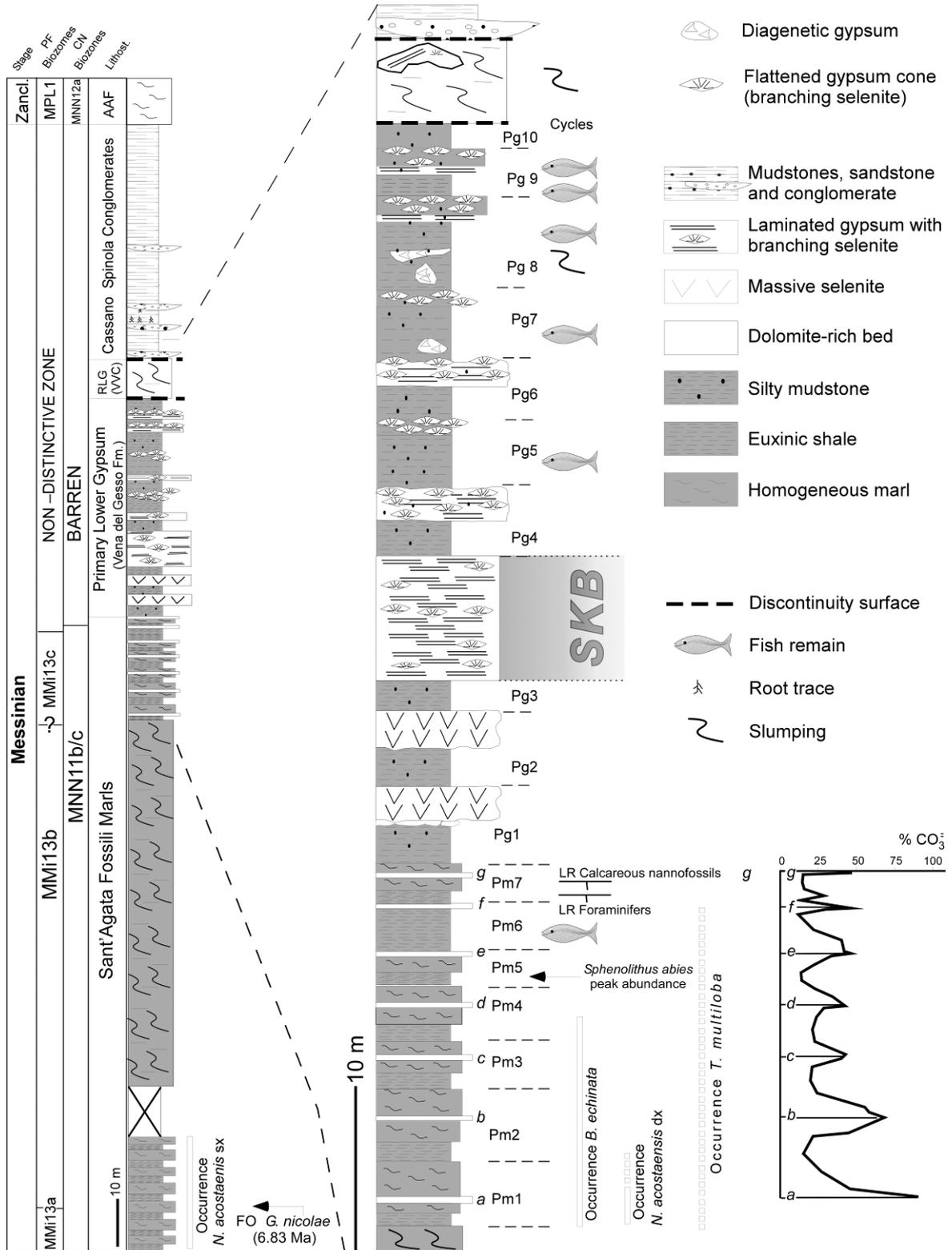


Fig. 4. The Verduno section (left) and detail of the upper part of the Sant'Agata Fossili Marls Formation and of the Primary Lower Gypsum unit (right) (from Dela Pierre et al., 2011). The lithologic cycles discussed in the text are reported. Letters in italics (*a* to *g*) indicate the carbonate-rich beds. The carbonate content of the upper part of Sant'Agata Fossili Marls is also indicated. SKB: Sturani key-bed; RLG: Resedimented Lower Gypsum (VVC: Valle Versa chaotic complex); AAF: Argille Azzurre Fm. Micropaleontological data are from Lozar et al. (2010) and Violanti et al. (2013).

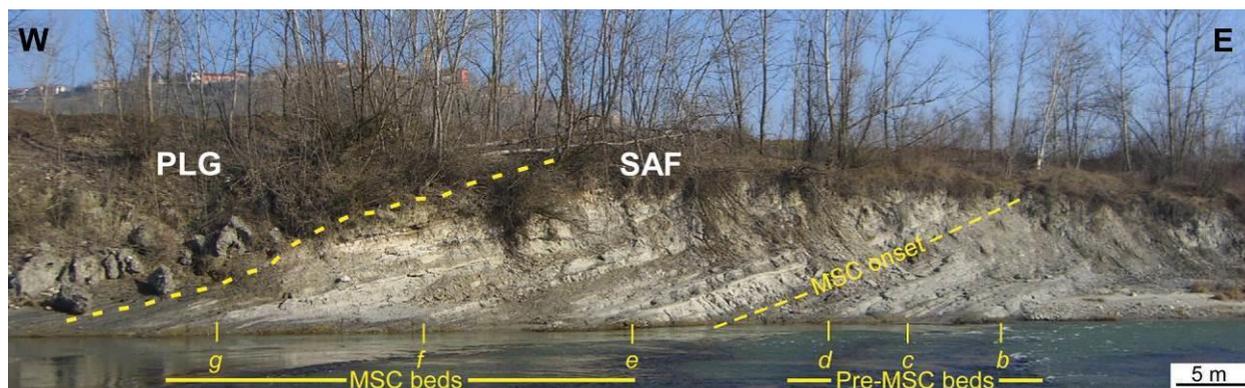


Fig. 5. Panoramic view of the lower part of the Verduno section, showing the boundary between the Sant'Agata Fossili Marls Formation (SAF) and the Primary Lower Gypsum unit (PLG). The letters indicate the carbonate-rich beds discussed in the text, that are recognizable for their whitish colour. Carbonate-rich beds belonging to cycles Pm1 and Pm2 (*a* and *b*) are not visible. From Dela Pierre et al. (2011).

Large flat conical structures (branching selenite), up to 2 m across, are clearly recognisable (Fig. 6D). According to Lugli et al. (2010), the branching selenite facies appears from the 6th PLG cycle (*i.e.* at around 5.84 Ma) at the Mediterranean scale, providing a tool for bed by bed correlations among sections in some cases separated by thousands of km. Its synchronous appearance seems to suggest a basin-wide hydrologic change, concomitant with an increased input of Atlantic waters in the Mediterranean as also suggested by the shift of Sr isotopes, and in contrast with the stronger continental signature of the lower cycles.

Above the SKB, seven cycles (Pg4-Pg10, Fig. 4) can be recognized. The gypsum beds composing some cycles (Pg4 and Pg6) are similar to the underlying key bed (Fig. 7A), except for their reduced thickness (2 and 1.5 m respectively) and the greater amount of clayey fraction (Fig. 7B).

The other beds (Pg5 and Pg7) are laterally discontinuous and are formed by decimetre-sized cones that float within a matrix of gypsiferous silty mudstones.

In the two uppermost beds (Pg9 and Pg10) gypsum crystals, larger than those composing the underlying beds (up to few centimetres long), are dispersed in a muddy matrix and are followed upward by laterally discontinuous

flattened cones. These layers have been affected by dissolution of gypsum that is partially replaced by calcite (Fig. 7C). The laminated silty mudstones interbedded to gypsum layers are locally deformed by slumping (*e.g.* cycle Pg8). The higher clayey fraction in these upper PLG cycles would point to an effective continental runoff from the neighbouring emerged Alpine chain, suggesting the influence of humid climate conditions at the end of the first MSC step (Dela Pierre et al., 2011).

Resedimented Lower Gypsum unit (RLG)

At Verduno, primary evaporites are sharply followed by slumped mudstones (Fig. 8A), enclosing metre-sized slabs of gypsum similar to those composing the upper PLG cycles. Carbonate rocks are also involved in the slump. This unit is 5 m thick but becomes thicker toward the NE, *i.e.* towards the distal portion of the basin.

Cassano Spinola Conglomerates Formation

A sharp unconformity (Fig. 8B) separates the slumped interval from the overlying Cassano Spinola Conglomerates Formation. At the base of this formation, a discontinuous dm-thick conglomeratic bed composed of rounded selenite crystals and clay chips is present. It is followed by grey to greenish muds that are locally very rich of land plant debris.

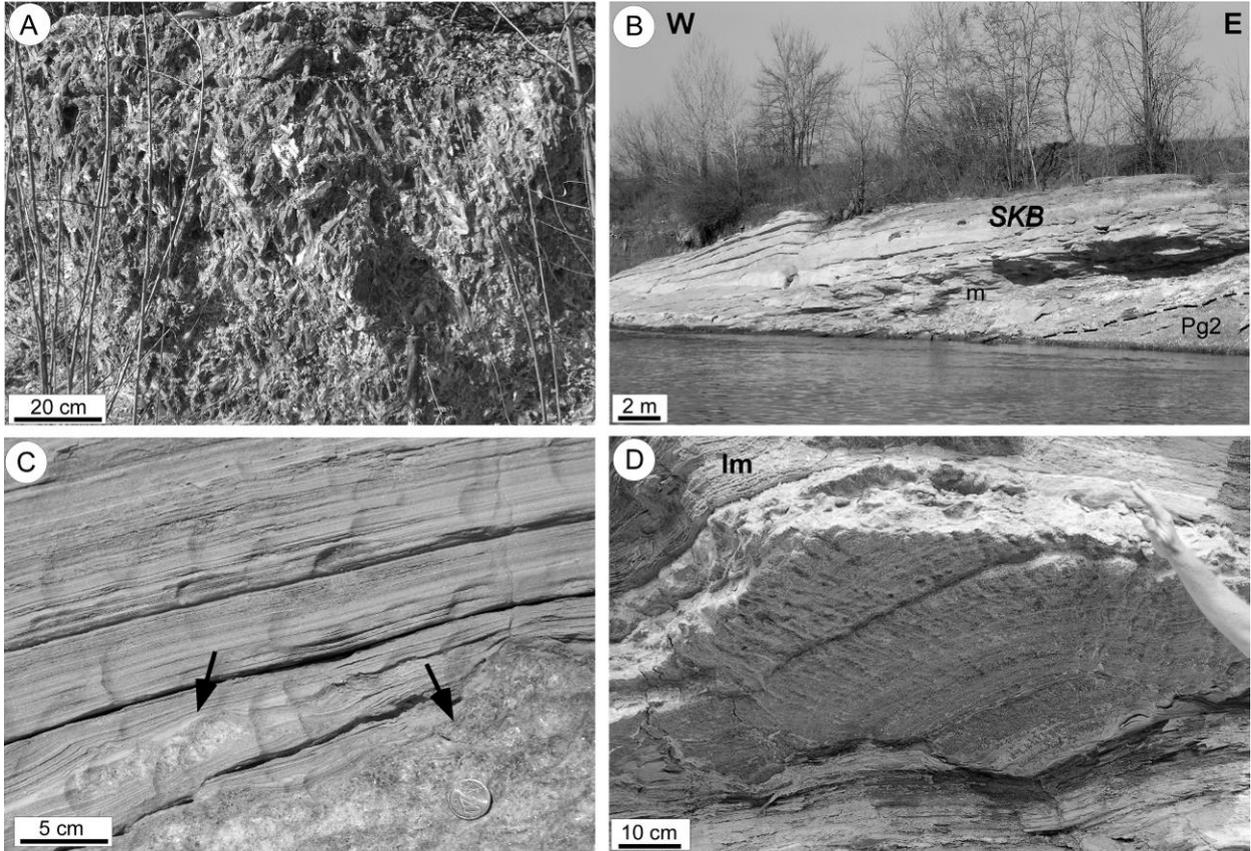


Fig. 6. Verduno section. A) Massive selenite bed belonging to cycle Pg2. B) Outcrop view of cycle Pg3 with the Sturani key-bed (SKB) and the underlying mudstone layer (m). The dotted line indicates the boundary between cycle Pg3 and the underlying selenite bed of cycle Pg2. C) Close up of the Sturani key-bed: note the finely laminated structure and the occurrence, in the lower part, of lenticular features composed of coarser gypsum crystals (arrows), corresponding to branching selenite. D) Metre-sized flat conical feature (branching selenite) at the base of the Sturani key-bed, grown within the laminated matrix (Im). From Dela Pierre et al. (2011).

The occurrence of root traces and mud cracks suggests episodes of subaerial exposure resulting in the formation of paleosols. Channelized fluvial conglomeratic layers, showing large scale cross stratification and containing remains of terrestrial vertebrates (Sardella, 2008; Colombero et al., 2013, 2014) have also been observed.

In the upper part, grey marls are present containing brackish molluscs (*Dreissena*, *Melanopsis*, lymnocyprids) of the Lago-Mare

biofacies, as well as brackish shallow water ostracods (*Amnycithere propinqua*, *Cyprideis agrigentina*, *Loxochonca muelleri*) that allow a correlation with the *Loxocorniculina djafarovi* Biozone (Carbonnel, 1978), recognized in the Mediterranean in the post-evaporitic interval (Clari et al., 2008). These deposits are sharply followed by Zanclean marine sediments (Argille Azzurre Fm.) recording the end of the Messinian salinity crisis

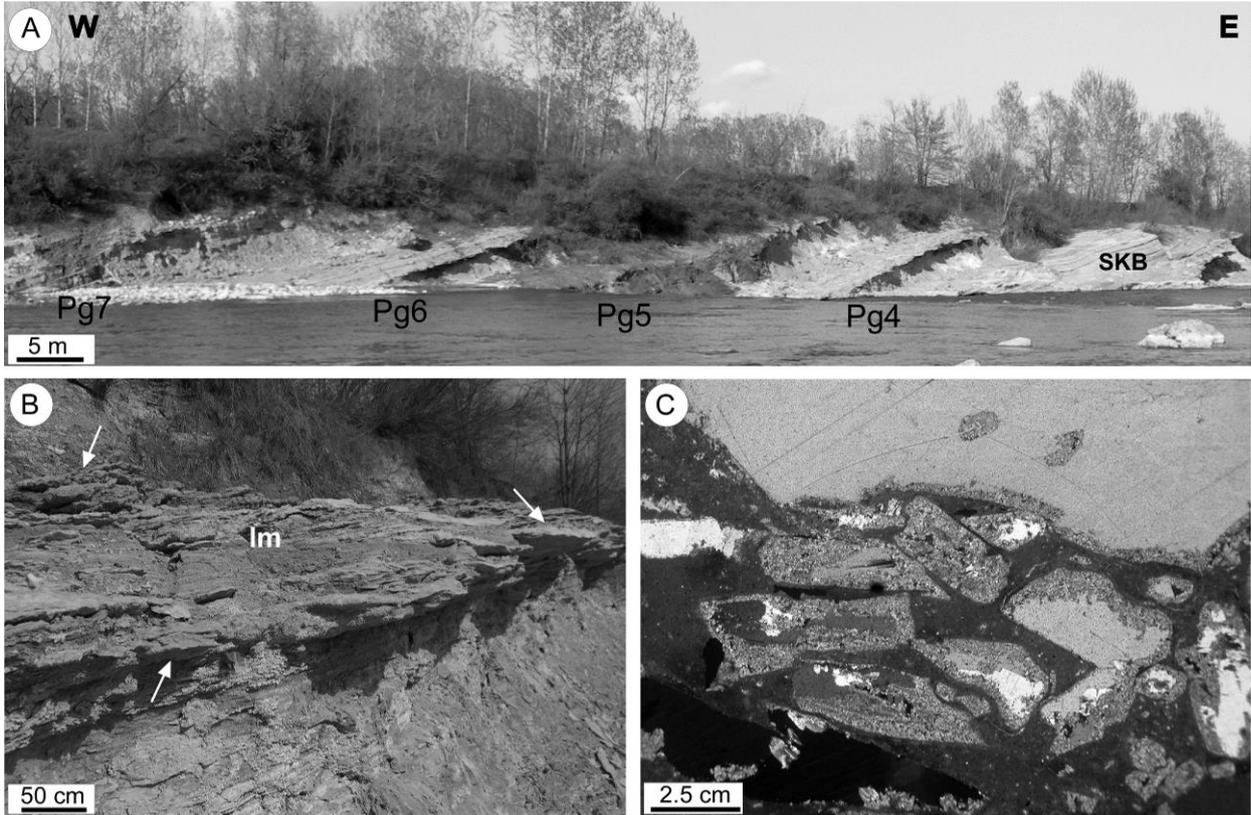


Fig. 7. A) Upper PLG cycles at Verduno: four cycles (Pg4-Pg7), made up of mudstones and thin gypsum beds, are recognizable above the Sturani key-bed (SKB). B) Outcrop view of the gypsum bed of cycle Pg4, consisting of flat conical features (arrows) within a laminated matrix (lm). C) Photomicrograph of a gypsum bed belonging to the upper PLG cycles: dissolved gypsum crystals that are partially replaced by calcite, are visible. From Dela Pierre et al. (2011).

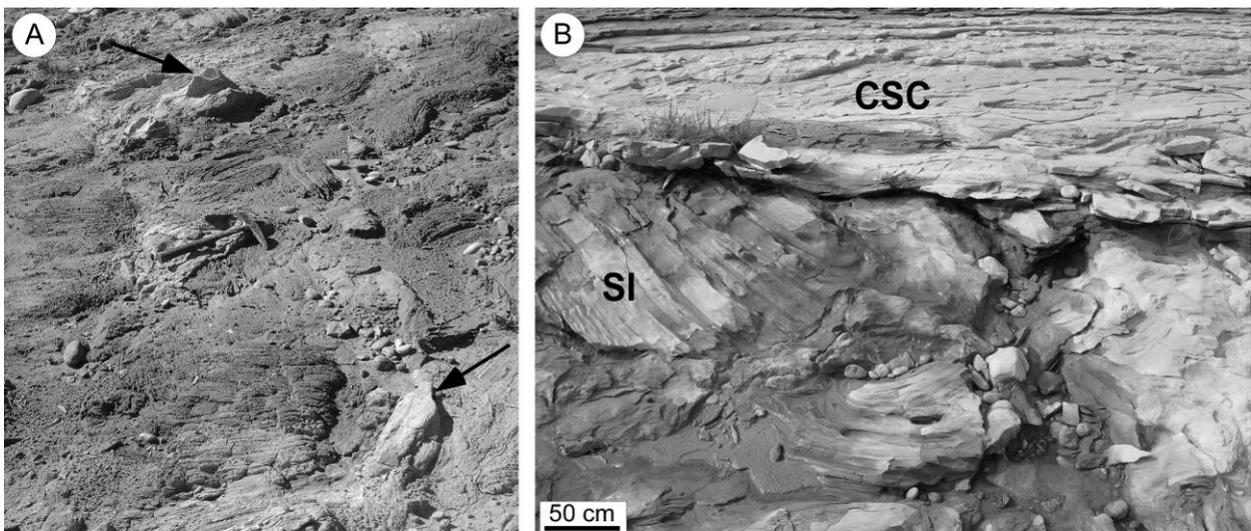


Fig. 8. Verduno section. A) Strongly deformed muddy sediments and carbonate beds (arrows) belonging to the slumped interval above the PLG unit. Hammer for scale. B) The unconformity separating the slumped interval (SI) below, from fine-grained sediments belonging to the Cassano Spinola Conglomerates (CSC) above. From Dela Pierre et al. (2011).

THE FOSSIL VERTEBRATES

Fishes

Remains of Messinian fishes are documented in the territory surrounding Alba since the half of the XIX century, when Sismonda (1846) and subsequently Costa (1865, 1867) described some fish skeletons from La Morra and Santa Vittoria d'Alba. The first attempt to provide a general overview of the fish-bearing localities from this area was that of Sturani (1973, 1978) who documented the existence of at least four productive sites. Thanks to the efforts of Oreste Cavallo and Jean Gaudant, several other sites

located along the Tanaro River were documented in the last three decades (e.g., Gaudant, 1979a, 1979b, 1981; Fourtanier et al., 1991; Cavallo et al., 1993; Gaudant & Cavallo, 2008; Gaudant et al., 2008), providing a nearly continuous record of the evolution of fish faunas in Tertiary Piedmont Basin throughout the Messinian, with material collected from the Sant'Agata Fossili Marls, Vena del Gesso and Cassano Spinola Conglomerates formations.

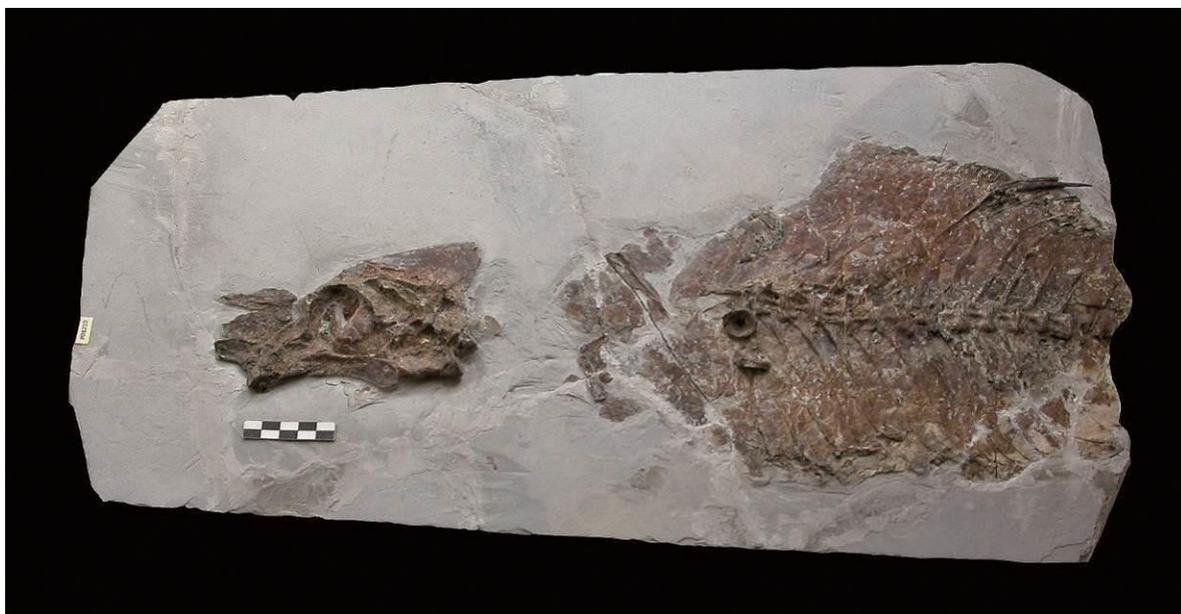


Fig. 9. Indeterminate seabream (Family Sparidae) from Pg9 cycle of the Primary Lower Gypsum unit of the Verduno section (Photo G. Repetto).

The early Messinian (pre-evaporitic) fish assemblages primarily consist of epi- and mesopelagic taxa, including clupeids, lanternfishes, codlets, pipefish and scombrids. The fish assemblages associated with the shales interbedded with the evaporitic deposits of the Vena del Gesso Formation exhibit a highly heterogeneous composition, ranging from fully marine (e.g., *Lepidopus*, *Scorpaena*, *Solea*, *Spratelloides*) to brackish/estuarine (e.g., *Aphanius*, *Atherina*, *Clupeonella*, *Gobius*) to freshwater taxa (*Leuciscus*, *Salvelinus*). A similar pattern is characteristic of the fish

assemblages of the Cassano Spinola Conglomerates Formation (Cavallo et al., 1993; Caputo, 2007). Overall, the composition of the Messinian fish assemblages of the Alba region is similar to that of other parts of the Mediterranean basin, documenting the emergence of significant environmental changes with the persistence of marine taxa throughout the Messinian, including a large part of the Salinity Crisis event (Carnevale et al., 2006a, 2006b, 2008a, 2008b, 2011).

In the Verduno section skeletal remains and otoliths of teleost fishes are relatively common

in the Sant'Agata Fossili Marls, Vena del Gesso and Cassano Spinola Conglomerates formations. The material collected from the Sant'Agata Fossili Marls and Vena del Gesso (PLG unit) formations mostly consists of relatively well-preserved articulated skeletons, in many cases associated with well-preserved plants and insect remains. The general trends of paleoenvironmental evolution recognizable from the analysis of the fish assemblages of the Verduno section are consistent with those observed in other sectors of the Alba territory, and more generally, of the Tertiary Piedmont Basin, documenting a more or less gradual

environmental transition from open marine to estuarine and lagoonal conditions, associated to the development of Messinian Salinity Crisis. The fish assemblage of the Sant'Agata Fossili Marls Formation is primarily characterized by pelagic fishes (e.g., lanternfishes, deep-sea hatchetfishes, clupeids, scabbardfishes, etc.), while that observed in the Vena del Gesso Formation is represented by abundant well-preserved remains of the Paleomediterranean Messinian cyprinodontid *Aphanius crassicaudus* and, very rarely, by gobies or sea breams.



Fig. 10. *Aphanius crassicaudus* from Pg9 cycle of the Primary Lower Gypsum unit of the Verduno section. This specimen shows part of the original pigmentation of the scales and caudal fin.

The hypoxic-anoxic conditions that persisted in the lower part of the water column leading to the deposition of the euxinic shales of the Vena del Gesso Formation resulted in the preservation of part of the original pigmentation of the scales, abdominal cavity and median fins in several specimens of *Aphanius crassicaudus*. Some of the specimens exhibit vertical black stripes running the depth of the caudal fin plus a nearly horizontal black stripe that run the dorsal-fin base (Fig. ZZ). In extant fishes, the black coloration derives from the dispersion of melanin in the melanophores. Scattered small black dots are also present on body scales and possibly represent preserved individual

melanophores, and the black stripes in the caudal and dorsal fins might be composed by the chemical residues of the original melanin pigments. Finally, the fish material from the Cassano Spinola Conglomerates is less abundant and concentrated in selected intervals, and consists of isolated bones of *Aphanius crassicaudus* and rare otoliths, that accumulated in small oligo-mesohaline lakes and coastal lagoons affected by periodic oscillations of salinity (Colombero et al., 2014).

Terrestrial vertebrates

A considerable amount of terrestrial vertebrate remains has been found in the Cassano Spinola

Conglomerates outcropping along the Tanaro River at Verduno (Fig. 11).



Fig. 11. One of the vertebrate-bearing layer outcrops along the Tanaro River where all the five lithofacies are visible.

The vertebrate-bearing layers lie about 20 m below the transition to the Argille Azzurre Formation, which marks the Miocene-Pliocene boundary and nearly 25 metres above the Valle Versa Cahotic Complex. The vertebrate-bearing layers of the Cassano Spinola Conglomerate Formation include five distinct lithofacies constituted by laminated grey to greenish silty-clays, bioturbated dark-brownish clay, and cross-bedded conglomerates with subcentimetric pebbles mostly represented by reworked gypsum (Colombero et al., 2014) (Fig. 12). A rather diverse assemblage has been collected from four of the recognized lithofacies, making Verduno one of the most rich Late Miocene vertebrate localities found in Italy up to now.

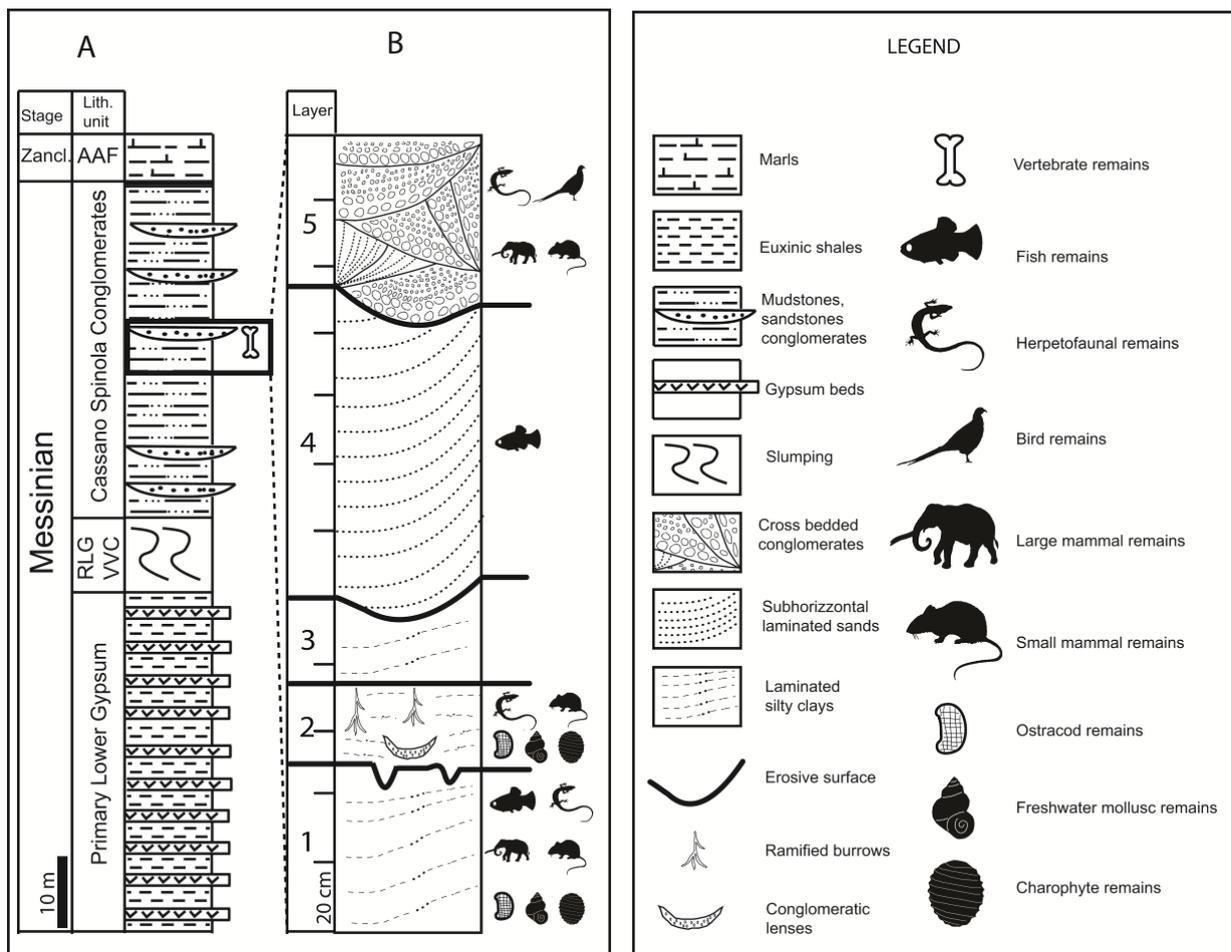


Fig. 12. The Verduno section with the stratigraphic position of the vertebrate remains. Lith. unit: lithostratigraphic unit; Zancl.: Zanclean; AAF: Argille Azzurre Formation; VVC: Valle Versa Chaotic Complex (modified from Dela Pierre et al., 2011).

This vertebrate assemblage includes remains of fishes (cyprinodontiforms and putative lophiiforms), amphibians (bufonids, ranids), reptiles (testudinids, geoemydids, lacertids, anguils, varanids, agamids, amphisbaenians, scolecophidians, colubrids), birds (galliforms, accipitriforms and strigiforms) and mammals (proboscideans, perissodactyls, artiodactyls, carnivores, insectivores, rodents and lagomorphs).

Herpetofauna. The amphibians are quite scarce, with only few remains referable to *Bufo* s.l. and *Rana* s.l. The reptiles are more common with several testudinids and squamate remains, among which are incomplete vertebral remains referable to *Varanus* and *Scolecophidia*, representing the second record for both taxa in Italy (Fig. 13).

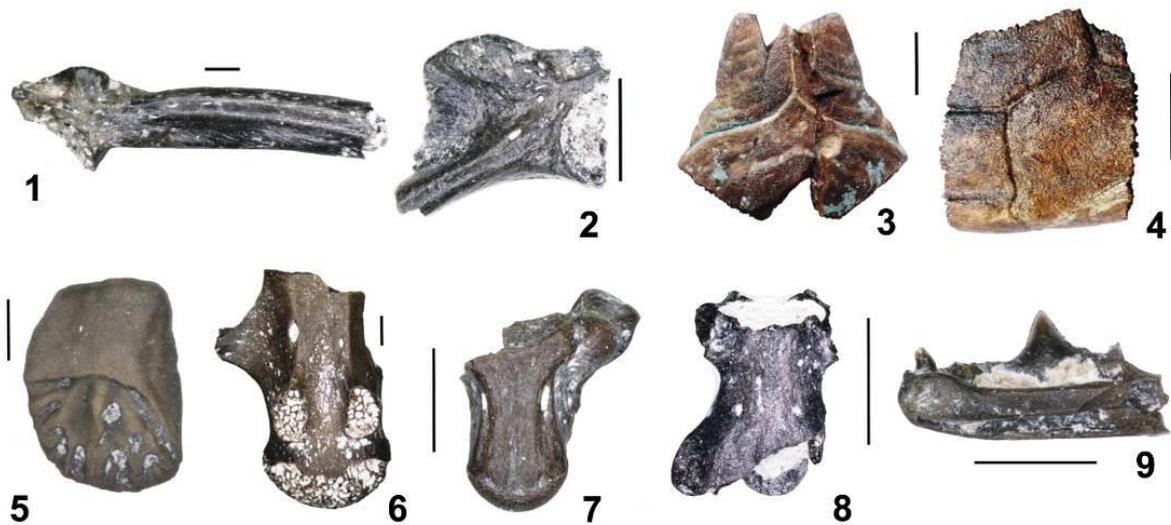


Fig. 13. Amphibians (1-2) and reptiles (3-9) from Verduno. 1: *Bufo* s.l. right ilium. 2: *Rana* s.l., left ilium. 3: *Testudo* sp. nuchal. 4: *Geoemydidae* indet. undetermined peripheral. 5: *Anguinae* indet. osteoderm. 6: *Varanus* sp. caudal vertebra. 7: *Amphisbaenia* indet. precloacal vertebra. 8: *Scolecophidia* indet. precloacal vertebra. 9: *Agamidae* indet. right dentary. Scale bars equal 1 mm (1, 2, 12-25) or 10 mm (3-11).

Avifauna. The birds are solely represented by four specimens. Due to their inadequate preservation, none of them can be identified at the specific or generic level, but they testify the presence of taxa belonging to four families: a Phasianidae, a galliform bigger than the Phasianidae, an Accipitridae and a Strigidae (Fig 14). Unfortunately, the poor preservation of the available material do not allows a more precise attribution, not even for the Strigidae, in which the pedal phalanges are usually diagnostic.



Fig. 14. Bird remains from Verduno. 1: Phasianidae gen. et sp. indet., right scapula. 2: Galliformes indet., left tarsometatarsus. 3-4: Accipitridae gen et sp. indet., left posterior phalanx 2/II. 5-6: Strigidae gen. et sp. indet., left posterior phalanx 1/II.

Small mammals. Murids are the most diverse and abundant taxa among the small mammals, including the abundant *Centralomys benericettii* and *Paraethomys meini*, and the rare *Apodemus*

gudrunae and *Occitanomys* sp. Cricetids are represented by a single species, *Apocricetus*

barrierei (Fig. 15), whereas the glirids are represented by *Muscardinus vireti* (Colombero et al., 2013). Other small mammal groups found at Verduno include a lagomorph, *Prolagus sorbinii*, and a soricid, cf. *Asoriculus gibberodon* (Colombero et al., 2014). The Verduno rodent assemblage shares some taxa with other Messinian post-evaporitic Italian localities bearing continental vertebrate remains, such as

Brisighella (central Italy) and possibly, Ciabo` t Cagna (NW Italy). Overall, the small mammal assemblage of Verduno shares all the recognized taxa with that of Moncuoco Torinese, a very rich Messinian locality placed in the Torino Hill, a few Km from the center of Torino (Angelone et al., 2011). The small mammals of both these localities are indicative of a late Turolian age.

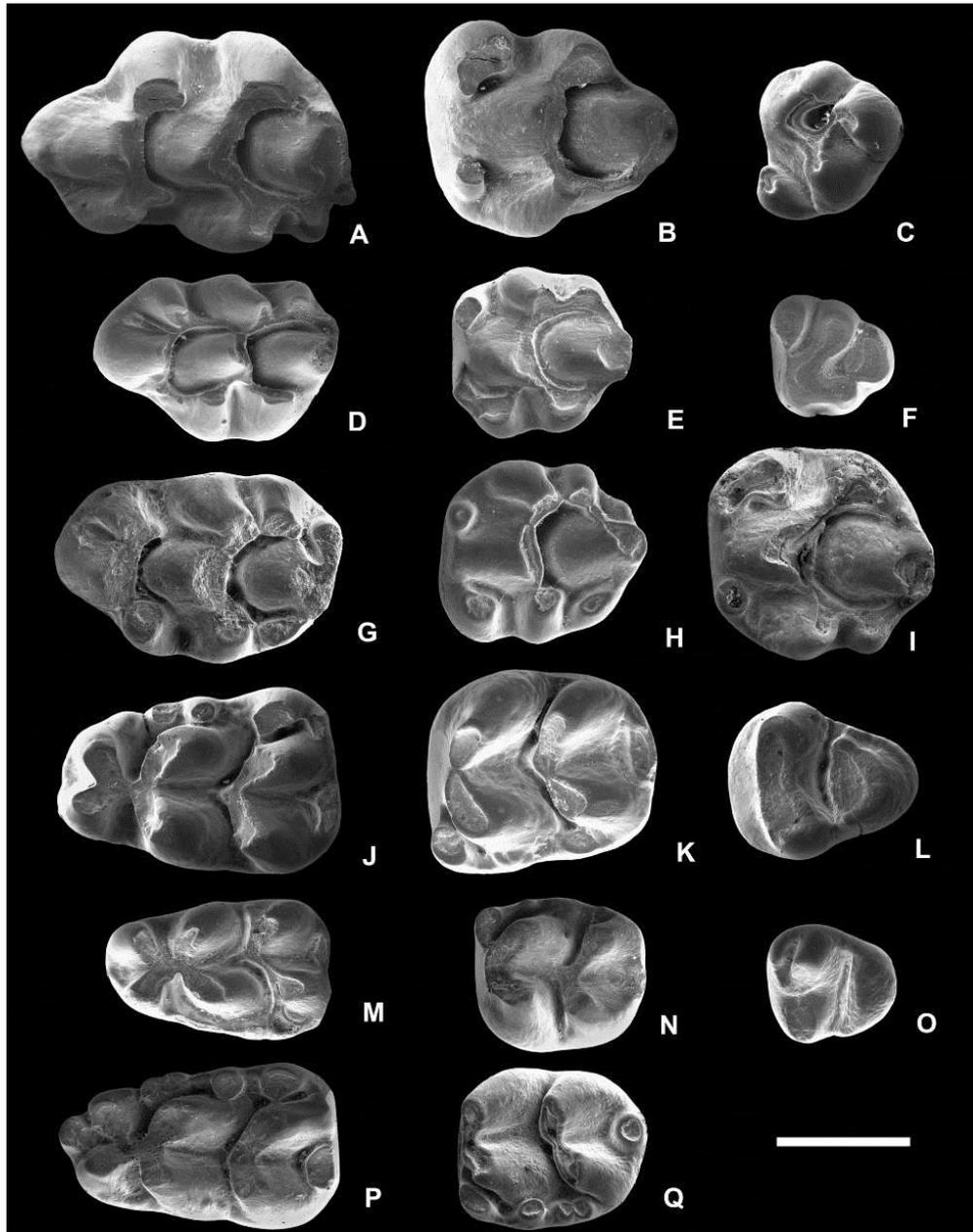


Fig. 15. *Paraethomys meini*: **A**, right M1; **B**: right M2; **C**: left M3; **J**, right m1; **K**, left m2; **L**, left m3. *Centralomys benericettii*: **D**, left M1; **E**, left M2; **F**, right M3; **M**, right m1; **N**, right m2; **O**, right m3. *Apodemus gudrunae*: **G**, left M1; **H**, left M2; **P**, right m1; **Q**, left m2. **I.** *Occitanomys* sp.: left M2. Scale bar: 1 mm.

Large mammals. The large mammal assemblage of Verduno contains at least 16 taxa of herbivores and carnivores. Among the herbivores, the presence of a Gomphotheriidae is testified by a partially complete articulated skeleton (Fig. 16). Unfortunately the extreme wear of the two available molars does not allow a proper taxonomical attribution. Rare isolated teeth document the presence of an indeterminate rhinocerotid taxon, and of the equid *Cremohipparion* cf. *C. macedonicum* (Fig. 17).

Remains of artiodactyls are much more abundant, with several specimens referable to the Cervidae *Euprox* sp., *Pliocervus* sp., and the Palaeomerycidae aff. *Palaeomeryx*. Bovi remains referable to the Bovidae *?Paraioceros* (*Hispanodorcus?*) *occidentalis*, *Gazzella* aff. *G. pilgrimi* and *Gazzella* sp. are relatively common. A single very large phalanx has been referred to the giraffid *Helladotherium* sp., and a few remains have been tentatively referred to a camelid taxon.



Fig. 16. Partially complete skeleton of an indeterminate Gomphotheriidae.

Even if the Carnivores are less abundant in terms of number of collected specimens, these are represented by at least five taxa, an indetermined Mustelidae, the canid *Eucyon*

monticinensis, the hyaenid *Hyaenictiterium* sp., and the felids *Pristifelis attica* and *Amphimachairodus* sp. (see Sardella, 2008).



Fig. 17. A: aff. *Palaeomeryx*, complete axis (on the left still embedded in the matrix). B: *Eucyon monticinensis*, fourth and fifth right metacarpal and two phalanges found in anatomical connection. C: *Amphimachairodus* sp., right calcaneum. D-E: *Pliocervus* sp., emimandibles. F: *Cremohipparion* cf. *C. macedonicus*, left upper first molar. G: Rhinocerotidae indet, right lower premolar, as found during the fieldworks. Scale bar: 1 cm.

The large mammal assemblage shows a balanced mixture of woodland and open space dwellers. Browsers with typical brachyodont dentition (e.g., *Euprox*, *Pliocervus*, aff. *Palaeomeryx*) are indicative of the presence of juicy and tender dicotyledon leaves, in contrast to grazers (e.g., *Cremohipparion*, ?*Paraoioceros*) which are concentrate selectors and eat grass and roughage. Nonetheless, due to the limited amount of collected specimens, any

paleoenvironmental inference exclusively based on the large mammal taxa should be regarded as tentative; however, the overall vertebrate assemblage confirms the presence of woodlands and open areas, characterized by waterbodies affected by periodic oscillations of the salinity.

The occurrence of relatively diverse vertebrate assemblages is certainly indicative of the paleobiogeographical relevance of the Piemonte area during the Messinian. This region

played a key role in dispersal of vertebrates between western and eastern Europe, and between them and other Italian districts at least during the latest Miocene.. The fall of several significant geographic barriers during the Messinian Salinity Crisis event probably favoured the biotic exchanges between different sectors of Europe. Many of the taxa recognized in the Verduno assemblage (e.g., *Euprox*, *Pliocervus*, *Helladotherium*, *Gazella*, *Eucyon*, *Amphimachairodus*) were widespread in

Eurasia, while others (e.g., *Paraethomys*) are reported also from Africa, or exclusively from eastern or western Europe. The Piemonte area, for instance, represents the western limit of the distribution of *Prolagus sorbinii* and, together with Borro Strolla and Brisighella, the eastern distributional limit of the genus *Apocricetus*.

This area, therefore, was a crucial check-point during the latest Miocene, that controlled the interchange of animals across the different parts of the circum-Mediterranean region.



Fig. 18. The vertebrate-bearing layers outcropping along the left bank of the Tanaro River at Verduno.

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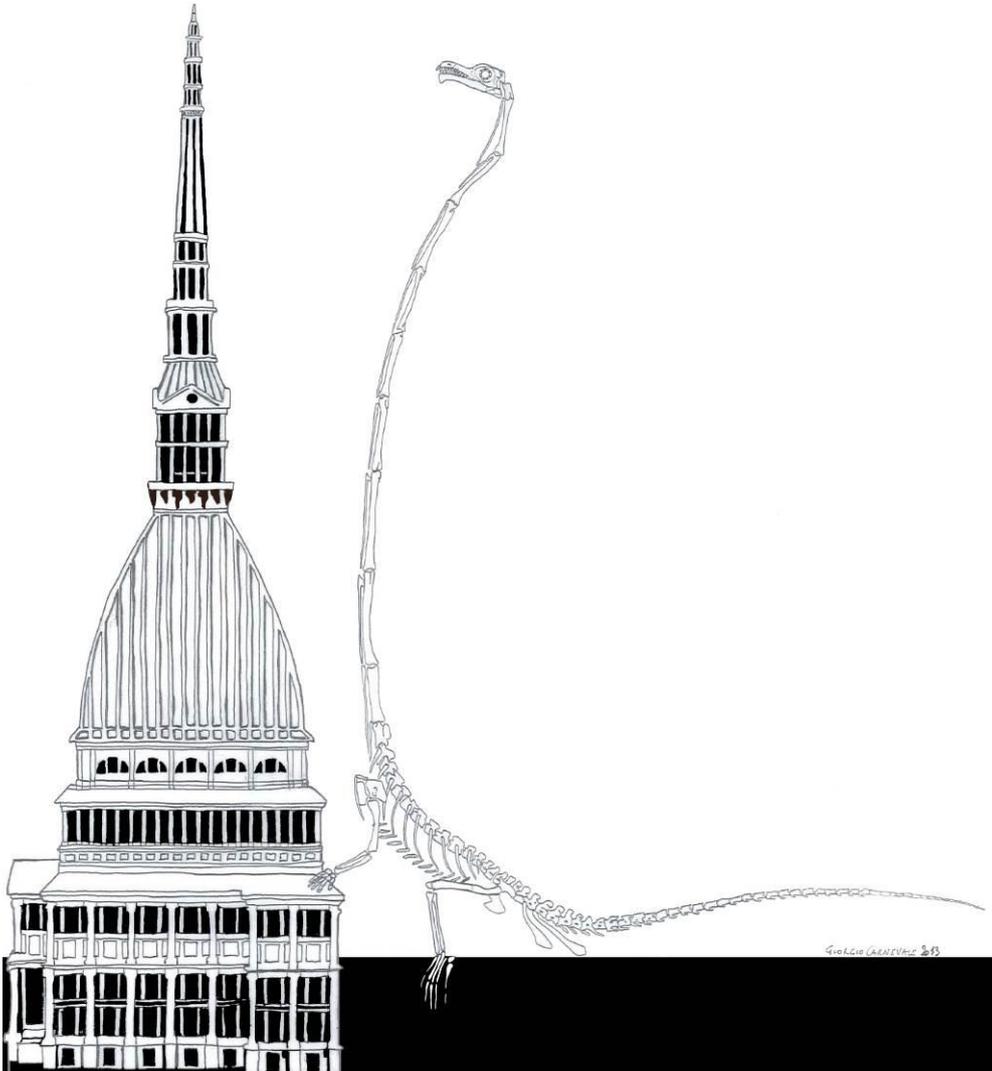
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LIST OF AUTHORS



XII EAVP Meeting – Torino 24-28 June 2014 – List of Authors

Abrams G.	24	Brusatte S.L.	34
Aguilera O.A.	38	Buffetaut E.	33
Aguirre-Fernández G.	3	Butler R.J.	34,140
Agustí J.	25,26	Cadena E.	35
Ahern J.	112	Campione N.E.	68
Alba D.M.	4,6,7,39,44,50, 51,98,111,123, 124,157	Cantalapiedra J.L.	36
Alberdi M.T.	53	Carlini A.A.	130
Almécija S.	124	Carnevale G.	4,37,44,45
Alonso R.A.	63	Carone G.	160,162
Álvarez Sierra M.A.	5	Carrillo-Briceño J.D.	38,130
Amson E.	139	Casanovas-Vilar I.	6,36,39,66,126, 146
Angelone C.	6,126	Cavallo O.	6
Araújo R.	75	Cavin L.	112
Arias-Martorell J.	7	Čermák S.	6
Aswan	117	Čerňanský A.	40
Augé M.L.	29,40	Cherin M.	41
Azanza B.	53	Chiappe L.	42
Azorit C.	149	Chicchi S.	20
Badamgarav D.	47	Chinsamy A.	42
Badgley C.	8,53	Ciochon R.L.	117
Bai B.	158	Cirilli O.	43
Bannikov A.F.	9	Clark J.M.	84
Bañuls-Cardona S.	97	Clauss M.	129
Barrett P.M.	10	Colangelo P.	131
Barry J.C.	8,11	Colombero S.	4,44,136
Bastl K.A.	139	Cordy J.-M.	24
Bayarmaa B.	47	Costeur L.	87,107
Bedosti N.	12	Cotroneo L.	162
Bello-Hellegouarch G.	7	Cox T.	131
Bellucci L.	13,79,132	D'Anastasio R.	12
Belvedere M.	14,15,16,108	Dagosto M.	138
Benoit J.	17,143	Dal Sasso C.	45
Benton M.J.	56	Dalla Valle C.	97
Benvenuti M.G.	43	Dalla Vecchia F.M.	19,46
Bernardi M.	18,157	Daxner-Höck G.	47,71
Bernardini F.	6	de Bruijn H.	154
Berto C.	97	De Esteban-Trivigno S.	48
Bertozzo F.	19	De Francesco T.	161
Bianucci G.	160	De Gracia C.	38
Bicchi E.	23	Dean M.C.	156
Bisconti M.	20,21,22,23	Del Favero L.	87
Blain H.-A.	24,25,26	Delfino M.	4,25,44,49,68, 98,134,136,142, 151,152
Blanco A.	27	Delson E.	4,50
Blanco Lapaz A.	26	DeMiguel D.	39,51,53
Böhme M.	126	Di Modica K.	24
Bolet A.	28,29	Díaz-Martínez I.	108
Bona F.	30	Díez Díaz V.	52
Bondioli L.	156	Domingo M.S.	8,53
Bonelli E.	23	Dong Z.	145
Bonjean D.	24	Eggenschwiler P.	112
Borths M.	139	Elton S.	54
Botfalvai G.	31	Eng R.	131
Bourdon E.	32	Engelbrecht A.	90
Bright J.	118		

XII EAVP Meeting – Torino 24-28 June 2014 – List of Authors

Erbajeva M.	47	Iurino D.A.	13,41,78,79,132
Eronen J.T.	36	Jadwiszczak P.	80
Escaso F.	100	Jagher R.	107
Espinoza-Campuzano C.A.	55	Jagt J.W.M.	135
Fabbri M.	19,56	Jaquier V.P.	81
Fagan M.J.	137	Jaramillo C.	38,130
Falkingham P.	112	Jian-Rong L.	96
Farke A.A.	99	Johnson M.M.	82,83
Farlow J.	14	Jordana X.	115
Femenias-Gual J.	57	Joyce W.G.	84,128
Ferretti M.P.	162	Kahlke R.-D.	101
Fitton L.C.	137	Kawada S.	131
Flynn L.J.	8,58	Kear B.P.	68
Foffa D.	59,60	Kimura Y.	39
Folie A.	61	Klein H.	18,112
Fordyce E.R.	3	Klein N.	85
Fornaciari B.	62	Köhler M.	115
Fornasiero M.	87	Kolb C.	149
Fortelius M.	36	Kostopoulos D.S.	101
Fortuny J.	157	Kotsakis, T.	6,86,87,99,120, 131,152
Frey E.	63,64,65,91	Kovalchuk O.M.	88
Fröbisch N.	141	Kowalski, J.	144
Frost S.R.	50	Krempaská Z.	89
Furió M.	39,147	Kriwet J.	90
Furrer H.	110	Kumar K.	49
Garcia G.	92	Kümmell S.	91
García-Paredes I.	5,39,66	Kupczik K.	137
Gebo D.L.	138	Landini W.	12
Geiger M.	67	Lapalus F.	92
Gendron K.	67	Latimer A.	93
Georgalis G.L.	68	Laurent Y.	32
Ghezze E.	69,87	Le Tensorer J.-M.	107
Giuntelli P.	4,44	Lebrun R.	94,119
Göhlich U.B.	47,70,71	Li Q.	158
González González A.H.	64,65	Lihoreau F.	95,119,133
Grandi F.	30	Liston J.J.	96
Gregorová R.	72	Liu J.	140
Gross M.	70,126	Liu Y.	158
Grosse I.R.	137	Loch C.	3
Gunnell G.F.	117	López Guerrero P.	5
Haarhoff P.	121	López-García J.M.	24,97
Harcourt-Smith W.E.	50	Lordkipanidze D.	25
Harzhauser M.	37,47,71	Loy A.	131
Hastings A.	73	Lu L.	84
Hausman S.	67	Luján À.H.	98
Hautier L.	74,105,150	Luzi E.	97
Hendrickx C.	75	Macchiarelli R.	156,157
Hernández Ballarín V.	5	Madern P.A.	36,39,146,147
Hír J.	6,126	Madurell-Malapeira J.	111
Hoch E.	76	Maiorino L.	87,99
Holec P.	89	Malafaia E.	100
Holwerda F.	77	Mallison H.	15
Hone D.	56	Manegold A.	121
Hordijk K.	5	Maniakas I.	101
Houssaye A.	85	Mao F.Y.	158

XII EAVP Meeting – Torino 24-28 June 2014 – List of Authors

Marcović Z.	154	Pandolfi L.	87,120
Maridet O.	47	Papazzoni C.A.	62
Marigó J.	57,102,114	Papini M.	43
Marivaux L.	150	Pavia G.	4,44
Marjanović D.	103	Pavia M.	4,44,68,111,121
Marmi J.	27	Peláez-Campomanes P.	5
Marra A.C.	160,161,162,163	Pérez Ben C.	122
Marramà G.	45	Pérez de los Ríos M.	123
Martin E.G.	104	Pérez-Pérez A.	7
Martin J.E.	49,74,105	Petti F.M.	18
Martin Suarez E.	50	Piller W.	47
Martín-Abad H.	106	Pina M.	124
Martini P.	107	Piras P.	87,99,131
Marty D.	108,112	Pirson S.	24
Marugán-Lobón J.	118	Piuz A.	112
Marzola M.	109	Posth C.	125
Mateus O.	75,77,109	Potau J.M.	7
Maul L.	126	Poyato-Ariza F.J.	106
Maxwell E.	62,110	Prieto J.	126,147
Mazelis E.J.	50	Přikryl T.	127
Mazza P.	44	Profico A.	131
Meijer H.J.M.	111	Prondvai E.	31
Menkem E.F.	105	Proz P.-A.	112
Menkveld-Gfeller U.	108	Puértolas-Pascual E.	27
Meyer C.A.	16,112	Puttick M.	56
Micklich N.	113	Quarantelli R.	22
Mietto P.	16,87	Rabi M.	84,128
Mílan J.	109	Rage J.-C.	40
Minwer-Barakat R.	57,102,114	Raineri G.	22
Mocho P.	52	Rana R.S.	49
Moncunill-Solé B.	115	Rayfield E.	118
Morales J.	50	Reguero M.	90
Morgan M.	8	Repetto G.	23
Mörs T.	90	Richoz S.	47
Moscato M.	131	Rivera-Silva H.	65
Mourer-Chauviré C.	32	Rizal Y.	117
Moyà-Solà S.	39,50,51,57,102, 114,116,123,124	Robles J.M.	39,98
Mulder E.W.A.	135	Rook L.	25,43,87,132, 137,156,162
Murray A.M.	117	Rose K.D.	49
Navalón G.	118	Rössner G.E.	129
Neenan J.	85	Rowe T.	93
Newbrey M.G.	106	Russo J.	109
Ngounou Ngatcha B.	105	Sahni A.	49
Niedźwiedzki, G.	34,144	Sala B.	97
Ntamak Nida M.-J.	105	Sala R.	26
O'Regan H.	54	Sánchez-Villagra M.R.	38,67,110,130, 134,142,149
O'Higgins P.	137	Sansalone G.	87,131
Oliver A.	5	Sanz J.L.	52
Orliac M.	119	Sardella R.	13,78,79,132
Ortega F.	52,100	Sarr R.	74
Ósi A.	31	Scherler L.	133
Otero O.	92	Scheyer T.M.	81,85,134,142
Padilla J.-M.	64,65	Schmutz S.	112
Palaia G.	44	Schoch R.	122,141
Palmer C.	104		

XII EAVP Meeting – Torino 24-28 June 2014 – List of Authors

Schouten R.	105
Schreiber H.D.	63
Schulp A.S.	135
Schweitzer M.	35
Ségalen L.	92
Seghetti S.M.	136
Shearer B.M.	50
Skutschas P.	141
Smith A.L.	137
Smith R.	138
Smith T.	49,61,138
Solé F.	139
Sookias R.B.	140
Steel L.	60,82,83
Stein K.	141
Sterli J.	126
Stinnesbeck W.	64,65
Strait D.S.	137
Strauss O.	142
Stubbs T.	56,59
Sulej T.	34,144
Sullivan C.	140
Szyndlar Z.	68
Tabuce R.	17,143
Talanda M.	144
Tanaka Y.	3
Tartarelli G.	21
Teresi L.	131
Thüring B.	112
Thüring S.	112
Tianyang P.	96
Tong H.	145
Tong Y.S.	158
Toro I.	26
Tschopp E.	77,136

Tuniz C.	6,157
van Dam J.	39
Van de Put J.M.M.S.	146
van den Hoek Ostende L.W.	5,39,126,146,147,151
van Heteren A.H.	148
Vasilyan D.	126
Vega Vera F.J.	64
Veitschegger K.	149
Vianey-Liaud M.	150
Vidalenc D.	139
Vila B.	27
Villa A.	151
Vlachos E.	152
Volkova N.V.	153
Wang H.B.	158
Wang J.	158
Wang L.H.	158
Wang T.	145
Wang Y.Q.	158
Wessels W.	47,154
Willmitzer F.	67
Wilson L.A.B.	155
Wizevich M.	112
Xing X.	84
Young M.T.	60,82,83
Zaim Y.	117
Zanolli C.	6,156,157
Zelenkov N.V.	153
Zhang Z.Q.	158
Ziegler R.	47
Zinoviev A.V.	159
Zorzin R.	62

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Eoplatax papilio (Volta, 1796) from the Eocene of Monte Bolca. Specimen in the collections of the Museo di Geologia e Paleontologia of the Torino University.

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