8TH INTERNATIONAL CONFERENCE ON FOSSIL INSECTS, ARTHROPODS & AMBER

SANTO DOMINGO 2019

ABSTRACTS

Edited by Paul C. Nascimbene

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Contents

Abstracts organized alphabetically by author (* denotes the presenter)

IPS President's Address

“Palaeoentomology”: An advanced traditional science dealing with the past with modern technologies

Dany Azar: President of the International Palaeoentomological Society

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Palaeoentomology began formally in the late XVIIIth Century with publications on fossil insects in amber. At the start of the XIXth Century, the first studies and descriptions of insects from sedimentary rocks appeared. This discipline then developed during the XIXth and beginning of the XXth centuries, and resulted in major works and reviews. The end of the XXth and the beginning of XXIst centuries (especially after the famous film “Jurassic Park,” produced by Steven Spielberg in 1993 and based on the eponymous novel of Michael Crichton, together with the discovery of new rock and amber outcrops with fossil insects of different geological ages in various parts of the world), witnessed a significant and exponential growth of the science of palaeoentomology resulting in a huge amount of high-quality international scientific work, using the most advanced analytical, phylogenetic and imaging techniques. Today our discipline is undergoing a wonderful intellectual radiation. Studies and understanding of phylogenetic relationships between insects and other terrestrial arthropods cannot ignore their fossil record, their palaeodiversity and palaeodistributions. Recent progress in knowledge of fossil insects improves our understanding of the real effects of global historical and biological crises; and brings to light the evolutionary scenarios of different entomological clades shaped over geological times.

The growing interest in palaeoentomology and its globalization brought about the formation of several serious multidisciplinary and collaborative scientific teams, and now with the present technologies of communication, most of the scientists from all over the world are collaborating in international teams without regard to distance or location. The spirit of international collaboration resulted in the creation of our society, IPS, which was born in 2001 in Krakow (Poland) and officially registered on the 1st of October 2015 in Paris (France).

Today we are holding our 8th Fossils x3 congress in the Dominican Republic, after several previous congresses (2016 in Edinburgh, Scotland, where ‘International Fossil Insects Day’ was declared and is now celebrated on each first of October; 2013 in Byblos, Lebanon; 2010 in Beijing, China; 2007 in Vitoria-Gasteiz, Basque region, Spain; 2005 in Pretoria, South Africa, where Fossils x3 [congress on Fossil Insects, Arthropods and Amber] was initiated by merging three congresses [Palaeoentomological Conference, World Congress on Amber Inclusions, and International Meeting on Palaeoarthropodology]; 2001 in Krakow, Poland; 2000 in Ribeirão Preto, Brazil; 1998 in Vitoria-Gasteiz, Basque region, Spain; 1998, in Moscow, Russia). Prior to these congresses there was the creation of the Fossil Insect Network (1996) in Strasbourg, France, under the auspices of the European Science Foundation.

Following 1996, there were several unsuccessful attempts to have a specialized scientific journal for our discipline, and today, with the significant growing numbers of publications on fossil terrestrial arthropods and amber, there has been an urgent need and challenge to create the official journal of the IPS as a specialized high-quality platform to bring together recent research and discoveries in our field in an expedited manner. Consequently, with the mutual efforts of IPS Executive Board members and Professor Diying Huang from the Nanjing Institute of Geology and Palaeontology, we have succeeded after long-term negotiations with several publishers to reach an agreement with Magnolia Press to create “*Palaeoentomology*” in late 2018. Today we are working on our third issue of this journal, to which we hope and wish for continued success.

I sincerely believe that scientific research on fossil insects and amber will continue to increase and prosper in the future. I am quite sure that significant and surprising results will emerge globally in tandem, and I wish great prosperity to our society.

KEYNOTE PRESENTATIONS

ECOLOGICAL AND EVOLUTIONARY SIGNIFICANCE OF DOMINICAN AMBER

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Amber from the Early to Middle Miocene of the Dominican Republic contains a rich paleobiota of extant genera that presently live in tropical Mesoamerica and/or South America, from fungi to vascular and non-vascular plants, worms, gastropods, small vertebrates (lizards, frogs, bird feathers, mammalian remains), and especially terrestrial arthropods. Preservation in this amber is also consistently the finest among all ambers. Some examples of distinctly neotropical taxa are provided, including the genus *Hymenaea*, the source genus of tree that produced the amber, among others. By the time of amber formation, however, there were also significant numbers of extralimital taxa, whose closest living relatives occur only on the Central American mainland, or even in the Old World. Some examples are discussed, including stingless bees (Meliponinae), certain butterflies, flies, termites, and ants, among others. These Caribbean extinctions reveal some fundamental aspects of the assembly of biological communities: **1**. There has been stasis of neotropical forests since at least the Miocene and probably much earlier; **2**. There has been dramatic loss of certain genera from a region or even continents, while the rest of the community persisted; **3**. Some of the lost taxa were quite common, possibly even ecologically dominant; **4.** Lost taxa may represent standard species turnover in communities, or represent special circumstances (due perhaps to an increasingly insular Hispaniola). The age of an amber deposit does not dictate its scientific significance; in the case of Dominican amber it provides rare insight into the stasis and evolution of the most biotically diverse type of ecosystem on earth.

AGE AND ORIGIN OF DOMINICAN REPUBLIC AMBER

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The age and origin of Dominican Republic amber has long been a subject of great interest to paleobiologists and evolutionary biologists because of the high quality and diversity of fossil inclusions in this mineral. In addition to its nonbiological content, which includes water, gases, and a variety of organic compounds, Dominican ambers include fungi, plants, protozoa, bacteria, invertebrates and vertebrates representative of the biodiversity of the ancient insular tropical forests in which they lived. Efforts continue to extract endogenous DNA from such inclusions; despite early claims, however, there have to date been no accepted successes. Proteins are another possibility, and research in this area is ongoing.

There has long been a debate concerning the origin of the Antillean biota, and how much light biotic inclusions in amber might shed on it. Over the years various ages were attributed to Dominican amber, but a turning point came with geological dating of the sediments in which the amber deposits were encased, providing a minimum age of Middle Miocene for origin and deposition (Iturralde-Vinent and MacPhee 1996; Iturralde-Vinent 2001 a, b). Although a number of recent papers endorse the idea that the mammalian fauna, at least, did not arrive in the West Indies until late in the Neogene, other contributions—mostly based on invertebrate taxa—suggest that at least some of the main islands were both subaerial and potentially colonizable in the late Paleogene. One such proposal, the GAARlandia hypothesis (Iturralde-Vinent and MacPhee 1999), has received a fair amount of recent attention. The GAARlandia landspan was conceived as a subaerial peninsular connection between northeastern South America and Cuba/Hispaniola/Puerto Rico (then conjoined) which existed around 35-32 My ago and subsequently foundered ca. 32 My ago (see also Iturralde-Vinent 2006; MacPhee and Iturralde-Vinent 2005). This brief land connection allowed colonization of the Greater Antilles by certain kinds of South American organisms. Others presumably reached the islands over time by overwater rafting and other dispersal mechanisms, thereby contributing to the present diversity of the island´s biota. Representatives of these taxa are not infrequently found in Dominican amber, including reptiles (lizards), birds (feathers, nesting materials), and mammals (insectivore, hair) in addition to a wide variety of invertebrates (chiefly arthropods). This suggests in turn the existence of a highly diverse—and possibly significantly ancient—biota, one that must be significantly older than the snapshot provided by amber inclusions. Yet the age and origin of Dominican Republic amber remains crucial to the paleobiogeographical debate, in part because amber inclusions permit calibration of molecular clocks and thus the timing of divergences between mainland and insular lineages. These issues will be presented and discussed during this keynote presentation.

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The remarkable palaeodiversity in Burmese (Myanmar) amber (mid-Cretaceous)

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The known palaeodiversity in Burmese amber from Myanmar has increased dramatically over the past few years. By the end of December 2018, 38 classes, 105 orders, 535 families, 881 genera and 1192 species had been recorded or described (including 8 classes, 67 orders, 488 families, 814 genera and 1117 species of arthropods).

Theodore D.A. Cockerell (1916) was the first to record inclusions, and by the end of 1920 had described 42 species of insects, arachnids and a millipede. The first plant was recorded by Dixon (1922). In the 1990s palaeoentomologists reinvestigated the collection at the Natural History Museum (London) and Rasnitsyn (1996) mentioned the first scorpion, snail and reptile skin (figured by Ross, 1998). Further material started to become available and Grimaldi et al., (2002) recorded the first conifers, nematode worms, velvet worm, bird feather and centipedes. Further new records of invertebrates, protists, plants and fungi were published over the following years (e.g. Poinar & Poinar, 2004). In recent years, new mines have opened up to supply the Chinese market, and amazing vertebrate inclusions have appeared such as frogs (Xia et al., 2015), lizards (Daza et al., 2016), birds (Xing et al., 2016a) and a dinosaur (Xing et al., 2016b).

Currently there are 33 orders of hexapods and 13 orders of arachnids known, which is the highest for any amber. Remarkably this includes extinct orders. Three new extinct orders of insects were named- Alienoptera Bai et al., 2016, Aethiocarenodea Poinar & Brown, 2016, and Tarachoptera Mey et al., 2017; however, the first two were recently included in the Blattodea by Vršanský et al., (2018). In addition, the extinct taxa Permopsocida and Lophioneurida were resurrected as orders by Huang et al., (2016) and Ulitzka (2018) respectively, and the extinct arachnid order Uraraneida was recorded by Huang et al. (2018) based on *Chimerarachne* Wang et al., 2018.

The total number of species has risen exponentially. In 1999 there were only 45 species known; however by the end of 2004, the total had more than doubled to 120, and by the end of 2009 had more than doubled again to 259 species. By the end of 2015, the total had reached 507, and by the end of 2018 had more than doubled again to an incredible 1192 species. 320 species were named in 2018, which is by far the highest number of species named from any amber in any one year.

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Reconstruction of amber forests using plants, lichens and fungi: a case study of the 'Baltic amber forest'

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The reconstruction of amber forests challenged scientists during the last decades, as interpretations of numerous arthropod inclusions led to conflicting assumptions about the structure and habitat types of these forests and prevailing climates. To gain a better understanding of amber source areas, we suggest that inclusions of plants, lichens and fungi need to be considered. Plants primarily supply the forest structure and are excellent indicators for environment and vegetation structure. Some are keystone species whose effect on forest structure is large, and disproportionately large relative to their abundance. Unfortunately, plants are rare as amber inclusions and only a few amber deposits bear noteworthy amounts of determinable botanical inclusions. Lichens and fungi are often indicative for certain forest types and climate; however, lichens are likewise considered extremely rare in amber. Fungal inclusions are common in amber from many deposits around the world, but usually only sterile mycelia are preserved, which hampers the taxonomic treatment of most fossils.

We suggest that despite their rarity, the value of such inclusions can be extremely high, especially when certain indicator or keystone taxa are identified. Using Baltic amber as a case study, we demonstrate that inclusions of plants, lichens and fungi can significantly support the reconstruction of amber forests. We evaluated the paleoecology of various seed plants and ferns based on data from comparable Paleogene fossils and assemblages, and evaluated the functional morphology of fossil lichens and microfungi. Our recent survey of Baltic amber also tremendously increased the total number of fossil lichens and microfungi that are highly specific to certain forest types and climatic conditions.

Our reconstruction of the 'Baltic amber forest' is based on 15 genera of four families of conifers, on six families of angiosperms (where diverse dwarf mistletoes were identified as keystone species) and on the evaluation of the functional morphology of approximately 60 lichen fossils and distinct morphologies of various calicioid fungi and lichens.

Inclusions of seed plants point to near-coastal / lowland habitats such as coastal swamps, back swamps and riparian forests, as well as mixed-mesophytic conifer-angiosperm forests with meadows and open areas. Several independent lines of evidence suggest warm-temperate humid but relatively well-illuminated temperate forests in the source area of Baltic amber.

This approach using multiple yet totally independent lines of evidence could be applied to other major deposits such as Dominican and Burmese amber, and possibly even to those preserving fewer inclusions of seed plants and cryptogams.

Burmese amber arachnids

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Fossils from the mid-Cretaceous (c. 100 Ma) Myanmar (Burmese) amber include all extant orders of Arachnida, including the earliest representatives of Schizomida, Parasitiformes, and Palpigradi. The most abundant and diverse arachnid order is the Araneae, with 44 families, 91 genera, and 167 species recorded to date. The araneofauna is dominated by haplogynes and palpimanoids, whilst araneoids are rare, and members of the RTA clade absent. In addition to the extant orders, an enigmatic spider-like arachnid, *Chimerarachne,* was described last year. What this animal tells us about spider evolution will be discussed. The arachnofauna is otherwise typical of a tropical rainforest habitat, which concurs with evidence from other Burmese amber biota.

TALKS

TALKS

POSTERS

Preliminary analytical studies of fossil resins from the Dominican Republic

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The purpose of these studies was an analysis and comparison of various samples of fossil resins from mines in the Dominican Republic, including both macro and microscopic observations. Various tests were performed: micro hardness (Vickers method); density measurements; infrared and Raman spectroscopy (FT-IR and FT-Raman); as well as thermogravimetric analysis (TG) and differential scanning calorimetry (DSC). UV induced fluorescence of the samples was also investigated. The different tests were applied to an examination of the resins' formation and age. The physicochemical characteristics of Dominican amber are discussed in relation to the geological setting and paleohistory of the deposits.

Direct Evidence of Multiple Levels of Predation across Several Taxa in Dominican Amber including an Eleutherodactylid Frog (Anura: Eleutherodactylidae) and Chilabothrus Boa snake (Squamata: Boidae)

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Vertebrate inclusions in amber are not common, and nearly all show evidence of predation. Therefore, many vertebrate inclusions are incomplete, have broken bones and/or are torn apart from the predation process. Although insects can sometimes be found within the same piece of amber, most are not associated with the vertebrate fossil, instead being merely victims of the same entombment process. An Eleutherodactylid frog preserved in a piece of Dominican amber shows direct evidence of predation across multiple taxon levels. Approximately half of the specimen retains skin, muscles, tendons and bone, while the other half is just clean bone. Additionally, the soft tissue tongue and stomach contents have been preserved. The tongue is approximately 7 mm long from base to apex and exhibits a fine pitted surface. The stomach contents occur on the anterior portion of the tongue and appear to consist of two distinct insect meals. One meal appears to be a common ground cricket, based on the presence of a well-preserved hind leg (femur is thickened compared to the tibia, and relatively long with apparently movable spines). The second meal consists of a mass of various unidentifiable insect parts and exhibits probable evidence of digestion. One well-preserved 11-segmented antenna is observed, as well as a portion of a second antenna. The frog itself was also a victim of a predator. Near the anterior portion of the tongue, a crimp is observed that transects its entire width. Within the crimped area, there are two hour glass-shaped indentations which are consistent with biting teeth. Although it is unknown what kind of animal may have made the bite marks, based on the orientation of the bite marks, it was most likely a lizard or small mammal (not a bird or snake). Interestingly, it is also possible that a snake was feeding on the frog, as there appears to be a single snake fang embedded in the frog's skin overlying the femur of the frog. The possible snake fang is approximately 3 mm long, strongly curved, and exhibits a groove over half of its length. The base of the fang appears to be ankylosed, and there are tears in the skin adjacent to the fang. Based on these features, the fang appears to be from a constrictor snake, potentially identified as a Boa snake (genus *Chilabothrus)*. Therefore, this remarkable specimen exhibits predation on multiple levels across several taxa and may contain the only snake fang found thus far in amber.

Beetle-mites (Oribatida) in Cretaceous ambers

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TALKS

Beetle mites (Oribatida) are very common in terrestrial ecosystems, with approximately 10,000 species known (Subías, 2004, updated online version 2018). However, they are rarely recorded as fossils, especially in pre-Cenozoic strata, where only 14 species have been described: 11 sp. from Spanish amber (Arillo et al. 2016); 2 sp. from Siberian Taimyr amber (Bulanova-Zachvatkina, 1974; Krivolutsky, 1976); and 1 sp. from Canadian amber (Sidorchuk & Behan-Pelletier, 2017). They have a long evolutionary history, with the oldest fossils coming from Paleozoic outcrops (Norton et al., 1988; Subías and Arillo, 2002) and belonging to the three basal living supercohorts not recorded in amber: Palaeosomata, Parhyposomata and Enarthronota. Oribatid mites are often overlooked in amber studies, primarily due to their minute size (300-600 μm), although there could be other reasons, such as their confusing systematics and their poorly known larval and nymphal stages. Despite this, at least five undescribed fossil oribatid mites are recorded in Lebanese amber (Azar pers. com.), and a huge collection of undescribed specimens is known from Myanmar amber (Rasnitsyn et al., 2016). At least 20 different families are known in Canadian amber (Sidorchuk & Behan-Pelletier, 2017). Increased knowledge of the fossil record should prove to be very interesting, since different species may be indicators of different ecological conditions: e.g., epiedaphic (litter), saxicolous (rocks), or arboreal. There may be a significant bias concerning the record of oribatid mites in amber, since aquatic or euedaphic ecosystems are less likely to be sampled (Solórzano-Kraemer et al. 2018).

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POSTERS

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A new Paleocene–Eocene insect-rich rainforest ecosystem near Gulgong, New South Wales, Australia

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A recently found fossiliferous outcrop 30 km north of Gulgong has resulted in the discovery of exceptionally preserved insect, plant and vertebrate faunas, which is tentatively given a Paleocene-Eocene age based on correlations with similarly aged flora elsewhere in Australia.

The fossil bearing layers are preserved within a highly silicified, fine grained ferricrete interbedded with veins of anthracite and underlaid by a distinct pebble conglomerate. There appears to be some lateral facies variation within the fossiliferous layer, which interlaces with nonfossiliferous sandy conglomerates and red-yellow siltstone over a 2 km transect. This suggests that the deposit likely formed in an environment adjacent to a shallow stream system, with the fossils forming in an inundated forest floor along the river banks.

The fossils found at the site show detailed preservation down to a cellular level in plants (pollen) and insects, including individual setae on beetle elytra. Some of the most numerous fauna are aquatic insects, which include nymphs of dragonflies and mayflies, as well as hundreds of culicomorph larvae and pupae, most of which are only decayed remnants, but, it does include a smaller number of excellently preserved specimens. The culicomorph larvae belong to the Chaoboridae and Chironomidae, with the chaoborids confidently placed into genus *Chaoborus* Lichtenstein, 1800. This identification is based on the antenna, maxilla and labial structure, as well as the placement and

TALKS

structure of the terminal syphon. These dominate the fossil remains in terms of abundance, which is indicative of low fish densities in the deposition environments, agreeing with the limited number of fish fossils found at the site (one species, seven specimens) despite extensive collecting.

The terrestrial community is less abundant, but highly diverse, consisting of tentatively identified specimens of an assassin bug, an emerging butterfly, wasps, ants, beetles (longicorn, etc.), beetle larva, unidentified insect wings, millipedes, and isolated bird feathers. The flora is similarly diverse, consisting of more than 30 species of dicotyledons, mainly angiosperms, and a few monocotyledons. Many of the leaf fossils show signs of insect damage, i.e. they have been chewed at the margin, bored, or mined.

This new site shows outstanding potential to improve our understanding of the east Australian Tertiary entomofauna, paleoflora, paleoecology and paleoenvironment.

POSTERS

Dominican Amber reveals local extinction, stasis, and community evolution in ants

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TALKS

Biological island communities represent ideal systems for investigating patterns and processes in evolutionary ecology. As natural noise-reducing laboratories that allow for discrete taxonomic sampling, islands have long been engines for discovery. Convergent adaptive radiations in Caribbean anoles lizards and Hawaiian spiders, for instance, have revealed the powerful shaping force of ecological selection pressures. Because of their diversity today and in the fossil record, the ants of Hispaniola represent a significant opportunity to explore ecological and evolutionary patterns in an island system, but with an important additional temporal dimension. Comparisons among fossil and extant ecomorphs in anoles lizards suggest long-term stasis in the region, however this is in contrast to taxonomy-based comparisons of insects, including ants. Here, we take a quantitative approach to assessing community structure over time in the region. Both present-day Hispaniolan and fossil amber communities are rich sources of phenotypic data: there are 147 species comprising 43 genera today, and 84 fossil species belonging to 32 genera described from amber. Moreover, there are well-established morphological proxies for ecosystem function and microhabitat in ants, which may be applied to fossil specimens: as a consequence of the high preservational fidelity of Dominican amber, it is possible to accurately quantify the morphology of fossil inclusions through light microscopy, confocal imaging, and X-ray based micro CT-scanning. Comparisons of modern and fossil morphospace reveal significant phenotypic losses since the Miocene, as well as lineages exhibiting remarkable stasis. What leads to local extinction in some groups, and striking stability in others? Are there ecological predictors for extinction? A large-scale comparative dataset allows for greater resolution in detailing the nature local phenotypic losses. Results also have bearing on the changing ecology and biogeographic history of the Caribbean.

POSTERS

TALKS

The limits of amber preservation: an ultrastructural and chemical approach with arthropods in resinites

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Amber and copal preserve organisms with a life-like fidelity and are well-known for conserving ultrastructural details over geological timescales. However, the quality of inclusions widely varies between amber deposits and seems to be coupled to numerous factors such as the chemistry of the resin, the sedimentary environment, or the grade of sclerotization of the inclusion. Studies regarding the chemical state of inclusions are rare and often limited in sample size or to a certain deposit. Within our project, we want to analyze the taphonomic pathway of arthropods in resinites via fossil and extant material from deposits over the world and of different ages. With the help of chemical analyses and microtome cuttings of arthropod inclusions, we want to gain a deeper insight into amber taphonomy and find out more about the limits of its preservation, as well as the factors that mainly determine the fate of the fossils. Here, we present our intermediate results on the basis of samples from Madagascar copal and Eocene Indian amber.

POSTERS

Diversity and biogeography of Cretaceous Ripiphoridae (Coleoptera: Tenebrionoidea)

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Systematic attribution of larvae and imagines of Cretaceous Ripiphoridae are summarized. Subfamilies Pelecotominae, Ptilophorinae, Ripiphorinae, and Ripidiinae are represented by eight genera and two types of larvae from the French, Myanmar, and USA ambers. Identifications of *conicocephalate* larvae from Russia, Canada, and Myanmar are discussed. Taphonomy aspects of imagines and larvae from the Mordellidae-Ripiphoridae clade and *conicocephalate* larvae are reviewed. The Mesozoic record of Tenebrionoidea is evaluated.

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TALKS

POSTERS

TALKS

Reflectance Transforming Imaging applied to insect imprint fossils

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Fossils preserved as sub-plane items, such as the vast majority of non amber-embedded insects, are challenging to photograph. Indeed, their relief features, composed of subtle depressions and elevations, can require multiple and/or very specific light orientations to be revealed. Among the computer-assisted photographic techniques that are revolutionizing natural and historical sciences, Reflectance Transforming Imaging (RTI) has seldom been applied to palaeontology. Basically, this technique combines multiple photographs taken under varied light orientations into a single photograph for which enlightenment can be modified at will. The resulting files are comparatively easy to produce and memory-friendly, therefore easy to disseminate. The approach was applied to a variety of insect imprint fossils. The necessary hardware and software, and a selection of cases, will be presented. This approach proves to be particularly well suited for documenting insect fossil imprints.

POSTERS

Rove beetles in mid-Cretaceous Burmese amber (Coleoptera: Staphylinidae)

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The mid-Cretaceous Burmese amber (ca. 99 Ma) from northern Myanmar is an invaluable substance for studying terrestrial paleodiversity in the Cretaceous and for reconstructing the origin and early evolution of various organisms entombed in it. The past five years have witnessed the rapid development of studies of Burmese amber, with 42 species and 33 genera (12 subfamilies) of Staphylinidae formally described from the fossil resin. These exceptionally preserved staphylinid fossils from such a critical period in the late Mesozoic provide significant information about the early diversification, phylogeny, and historical biogeography of the beetle family Staphylinidae. In particular, recent discoveries have unique and important implications for understanding the early evolution of parental care in staphylinoid beetles, the origin of termitophily in aleocharine rove beetles, and for reconstructing particular paleoecosystems in the mid-Cretaceous.

TALKS

POSTERS

Myrmicine ants (Hymenoptera: Formicidae) in Miocene amber of Zhangpu, China

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The middle Miocene (Langhian) Fotan Group of Zhangpu County (Fujian Province, SE China) contains a rich paleoflora including leaves and fruits of dipterocarp trees, reflecting a northern expansion of tropical dipterocarp forests during the mid-Miocene Climatic Optimum. A highly fossiliferous amber of dipterocarp origin also occurs, containing a remarkable ant fauna with more than 1 000 individuals from 9 subfamilies found to date. Myrmicinae are prevalent (65% of the total ants), followed by Dolichoderinae (9%), Ponerinae (8%), and Formicinae (6%). Myrmicines comprise more than 30 extinct species distributed in 17 extant genera, among which *Carebara and Pheidole* are largely dominant (33% and 28%, respectively). *Lophomyrmex, Crematogaster,* and *Tetramorium* are also well represented (*ca* 7% each), and several occurrences are the first fossil records of extant genera (e.g., *Cardiocondyla, Gauromyrmex, Lordomyrma, Meranoplus, Proatta*). The specific richness is rather high within most genera, with distinct morphological features reflecting various ecological lifestyles from hypogaeic to arboreal species and supporting the hypothesis of a well-developed mature forest. Some specimens are also fossilized in behavioral position, just as their living relatives, notably the typical repelling posture of the "acrobat ants" *Crematogaster* with the sting overcoming the mesosoma and suggesting that the ecological behavior is highly conservative through time. Then, the presence of *Yunodorylus* (Dorylinae) in colonies of *Pheidole* would suggest a possible association of these genera nesting in soils, which has not been observed among the current species. Overall, the ant fauna of Zhangpu amber is mostly similar to the present-day fauna that is found in tropical rainforests from SE Asia and eastern Australia, particularly the dipterocarp forests of Borneo, Philippines or Malaysia. Our findings highlight a closely related geographical distribution of some Australasian ant genera and dipterocarp forest ecosystems.

Upper Cretaceous dinosaur bonebed amber: western Canadian deposits

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Over the last few years, several Upper Cretaceous dinosaur bonebed deposits containing amber have been discovered in western Canada (Saskatchewan and Alberta). The exceptional preservation potential of a wide range of organisms, coupled with the chemistry of the resin, can provide clues about the past ecology and environments in which dinosaurs lived. The uppermost Cretaceous geological record is also characterized by a limited number of amber deposits globally. New deposits within this time interval help to address a 20-million-year gap in the amber record that extends from the Upper Cretaceous to the Eocene. Recent results demonstrate the exceptional potential of amber as a new source of paleontological information in bonebed studies. To date, amber from the Pipestone Creek bonebed (Alberta) has yielded several arthropods and a fragment of feather. New taxa belonging to the family Mymarommatidae and the order Psocodea have been described. The δ13C values of the Pipestone Creek amber are close to those of other Albertan deposits, suggesting the absence of a marked ecophysiological stress during the time of resin production. The δD values provided an approximate air temperature of 27 °C at the time of resin secretion, and suggest a continental pattern of precipitation in the region. Amber from the 'Scotty' *Tyrannosaurus rex* bonebed (in southern Saskatchewan) did not yield any arthropod inclusions, but the stable isotope data suggest a potential ecological stress, and exhibit a strong marine influence. This gives new insights into the presence of Western Interior Seaway remnants at the time. FTIR spectra of amber from both sites are compatible with a botanical source among the Cupressaceae. Vertebrate material from a more productive amber deposit, Noije Bum in Myanmar, has also been studied in order to provide a reference point for the discoveries in North American deposits, and improve the understanding of the remains found in Canadian amber.

A new basal mantis (Mantodea) and the first North American 'hairy' cicada (Hemiptera : Tettigarctidae) found among a recently expanded entomofauna from the Late Cretaceous (Cenomanian) of Labrador, Canada

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The Redmond Formation is one of the rare Mesozoic exposures known from the Quebec/Labrador Peninsula, and is only found in an abandoned iron ore mine located near Schefferville. This ferruginous argillite deposit of probable lacustrine origin and Cenomanian age has been known to contain fragmentary insect impression fossils for most of the time since its discovery in the late 1950s. However, only 5 species have been formally described, along with mentions of genera belonging tentatively to Blattaria, Schizophoridae, Cupedidae, and Haliplidae. Fieldwork undertaken in the Redmond Mine in 2013 and 2018 has resulted in a significant expansion of the species richness and functional diversity of this mysterious entomofauna. The specimens we present here are assigned to families or orders that were heretofore not represented in the Redmond Formation. The hypothesis of a lacustrine depositional environment is strongly supported by the discovery of the first relatively complete representatives of mayfly nymphs (Ephemeroptera), belostomatid hemipterans and hydradephagan coleopterans known from this site. We also report the first occurrences of a lacewing (Osmylidae), planthoppers (Fulgoromorpha), leafhoppers (Cicadellidae), orthopterans, and hymenopterans. Together, these new specimens contribute substantial information on insect evolution and biogeography at a pivotal time in the evolution of terrestrial ecosystems for a poorly represented part of the Cretaceous world. Their descriptions are only beginning, so a precise quantitative diversity estimate for the site would be premature at this moment.

Among these recent collections, descriptions are nearly complete for two rare specimens. The first consists in a pair of outstretched hind wings flanking a partial clavus. The wings' shape and venation characters strongly suggest that they belong to a new basal mantis genus (order Mantodea). This would represent only the second occurrence of this order for Cretaceous North America. The second specimen consists of a set of two incomplete superimposed tegmina of definite cicadomorphan affinity. Its wing venation characters suggest it is a new genus of the 'hairy' cicadas (fam. Tettigarctidae; subfam. Tettigarctinae). This is the first occurrence of tettigarctids in the North American fossil record, and so this discovery expands an already global Cretaceous distribution for a now relict cicadomorph family. Mantises and 'hairy' cicadas are rarely preserved in the fossil record, so their co-occurrence in the Redmond Formation demonstrates the commendable potential of this site to contribute to our understanding of insect eco-evolutionary trends in Cretaceous North America.

The Molteno Formation (South Africa), a testimony of the diversity of Triassic Odonata

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Extant odonates (damselflies and dragonflies) represent only a small subset of the historical biodiversity of the group Odonata. Compared to most other insect orders, its fossil record is rich. Many of the successive fossil sister-groups of crown-Odonata have been documented and classified, essentially based on wing venation, which is very elaborate in these insects. Yet, some periods of time and geographical areas are not well documented, such as the Triassic in the Southern Hemisphere.

We studied new material from the Molteno Formation (Karoo Basin, South Africa), dating from the early Carnian (Late Triassic). Two of the newly described species were represented by incomplete material. We attempted to reconstruct the missing parts using a repeatable, standardized method based on Thin Plate Spline deformation.

The new specimens display unique wing venation patterns, warranting the erection of new species, but also questioning venation homologies. Different taxa occur, including the Triadophlebiomorpha and Triadotypomorpha, each represented by a new species. Both taxa were previously only known from Northern Hemisphere localities. Protomyrmeleontidae, a family known from the Northern Hemisphere and some Australian localities, also occurs. The investigation of a new specimen allowed us to propose new wing venation homologies, up to now unsettled, for the entire group. As a whole, the new specimens further demonstrate that odonate groups had a worldwide distribution by the Triassic, and that they were very diverse.

Diversity and bias in the fossil record of spiders preserved in lacustrine deposits

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TALKS

The fossil record of spiders is dominated by preservation in amber and lacustrine deposits, although most formally described specimens are from amber. Significant spider-bearing lacustrine deposits have received little attention since the late 1800s and early 1900s. Here, fossil spider assemblages in Mesozoic and Cenozoic lacustrine deposits are compared to identify patterns in diversity and biases in preservation with regard to time and environment. The deposits are compared on the basis of family richness and composition, size of individual spiders, life mode (web weaving vs ground dwelling), and sex.

Fossil spider assemblages preserved in lacustrine deposits differ in diversity and the types of biases reflected. The Crato Formation (Brazil: Cretaceous) is dominated by larger aerial web-building spiders. The Green River Formation (Colorado: Eocene) appears to be dominated by smaller aerial web-building spiders, while in contrast, most spiders from the Florissant Formation (Colorado: Eocene) and Aix-en-Provence (France: Oligocene) are larger. Ground-dwelling spiders are particularly abundant in the Aix-en-Provence assemblage. There is no clear trend in sex ratio for lacustrine deposits.

Overall, there is greater diversity in Cenozoic deposits, especially amber. It is clear that some lacustrine deposits capture a different window of the arachnid community compared to amber. The differences are likely the result of depositional environment and different taphonomic filters across lacustrine deposits and compared to amber. The combination of lacustrine and amber data presents the most complete picture of spider diversity in the fossil record.

POSTERS

Mesozoic Fossil Heteroptera from northeastern China

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TALKS

In the past decade, we have recovered Heteroptera from the Jiulongshan and Yixian Formations of northeast China, belonging to 15 families, 53 genera, and 61 species, providing a solid foundation for studying the role played by Heteroptera in Late Mesozoic ecosystems. Among the 15 families, specimens of Rhopalidae, Vetanthocoridae, Primipentatomidae, and Venicoridae, respectively, represent the first fossil records for these particular families. Specimens of Miridae, and Cydnidae are the oldest found thus far. Specimens of Cydnidae, Ochteridae, Naucoridae and Yuripopovinidae represent the first fossil records for these families in China. In addition, some especially well-preserved specimens provide auxiliary evidence for phylogenetics and biology.

For instance, although the phylogeny of Coreoidea (*sensu lato*) has been discussed in former studies, it has remained controversial. Recently, we collected quantities of well-preserved fossil specimens from the Yixian Formation. Based on morphological characters from both fossil and extant species, we attempted to elucidate the phylogenetic relationships of each family in the Coreoidea (*sensu lato*). A major conclusion of the phylogenetic analysis was that Pyrrhocoroidea, Coreoidea, Idiostoloidea, Lygaeoidea and Yuripopovinidae are monophyletic groups; Idiostoloidea and Lygaeoidea were supported as sister groups. The family Piesmatidae was shown to belong to Lygaeoidea. This result can be simplified in the following way: Pyrrhocoroidea + (Yuripopovinidae + (Coreoidea + (Idiostoloidea + Lygaeoidea))).

POSTERS

Blood feeding, or hematophagy, occurs in very few families of extant true bugs. Up until now, only one fossil species of hematophagous bug, *Quasicimex eilapinastes,* has been described from mid-Cretaceous Burmese amber. Based on abundant fossil material from China, we used energy-dispersive X-ray spectroscopy (EDS) to analyse the geochemical composition of seven true bugs from the Early Cretaceous Yixian Formation, including three specimens of Torirostratidae and four specimens of other heteropterans from the same locality and horizon representing the phytophagous families Pachymeridiidae and Venicoridae, as well as the predaceous families Reduviidae and Vetanthocoridae. Our geochemical analysis suggests that specimens of the family Torirostratidae contained distinctly higher iron concentrations than those of other lineages, possibly due to blood meals. The family Torirostratidae thus may represent the earliest evidence of such feeding behaviour among heteropterans. It is likely that these species played a significant role in the ecology of the Jehol Biota, as evidenced by their relative abundance. It appears increasingly clear that the use of vertebrate blood as a food source was likely well-established by the Early Cretaceous.

Upper Cretaceous Texas Amber: Its first biological inclusions

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TALKS

Amber has recently been found in North Central Texas, at the stratigraphic level of the non-marine Dexter Member of the Woodbine Group. Chromatically, it varies from pale yellow to yellow, orange to reddish. Some clasts are transparent, whereas others are dark brown or white opaque. Sizes vary from 1mm to 30 mm in diameter. When broken, they present conchoidal fractures.

The North Central Texas amber has been chemically characterized by the following analytical techniques: ^{13}C NMR, ^{1}H NMR, FTIR and GC/MS. These studies assign the Texas amber to Group A, equivalent to Class 1b, and as such, the botanical origin is considered to be coniferous.

Palynologic studies of the sediments were carried out to elucidate the paleoenvironment of the deposition. Results show a low diversity palynomorph assemblage suggestive of a nearby source, that is composed primarily of conifer pollen (*Pinuspollenites* spp.) and fern spores (such as *Deltoidospora hallei, and Biretisporites potoniaea)*. The assemblage indicates a non-marine, fluvial deltaic environment. The kerogen composition of the sediment is also characteristic of a fluvial system. Based on stratigraphic and palynologic data, the age of the amber is assigned to the Early Cenomanian (ca. 97 Ma).

POSTERS

The observation of abundant charred wood and fusain present at the horizon where the amber was found indicates the direct effect of fire at or immediately prior to the time when the deposit was laid down. Macroscopic and microscopic analyses of the sediments, including SEM imaging, have led to its identification as charcoal. Given the degree of charring, it is doubtful that amber would survive such fires. The amber and the charcoal association is possibly due to hydraulic sorting. It appears that the material was fluvially transported. The presence of fine sand in the sediment provides additional evidence of a fluvial contribution, suggesting a stream-fed swamp-like environment. Conifer wood charcoal is common in other amber localities worldwide.

The search for inclusions in the Texas amber is in progress. The inorganic inclusions found are: spherical and elongated bubbles, bubbles inside bubbles and acicular crystals. Some amber pieces present abundant plant debris. An ovoid microinclusion, about 800 microns long, a headless beetle (Coleoptera) possibly in the suborder Polyphaga, was found in a piece of clear, yellow-orange amber. Other microinclusions are currently being imaged for identification. Without question, there is a Cretaceous microbiota in the Texas amber waiting for further analysis.

TALKS

Mesozoic cercopoids (Hemiptera: Cercopoidea) from China and Myanmar

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Cercopoidea Leach, 1815, is the second largest group of modern Cicadomorpha, comprising more than 3000 described species, distributed worldwide. Traditionally, the superfamily Cercopoidea includes five extant families and three extinct families (Procercopidae, Cercopionidae and Sinoalidae) from the Mesozoic. Many well preserved Mesozoic cercopoids collected from the Jurassic of northeastern China and from mid-Cretaceous Burmese amber have provided new insights into the morphological diversification and early evolutionary history of Cercopoidea.

The oldest lineage of Cercopoidea is Procercopidae, which includes 8 valid genera from the Early Jurassic through the Early Cretaceous of Australia and Eurasia. Procercopidae is the most abundant group found in the Middle to Upper Jurassic Daohugou beds (Haifanggou Fm.) in northeastern China, covering about 40% of all Cicadomorpha specimens collected, with most individuals belonging to *Anthoscytina* (eg., *Anthoscytina longa*); and with a lesser number in the genera *Jurocercopis* and *Titanocercopis*. To date, 4 species of *Anthoscytina* have been reported from Daohugou biota. The new find reports two new monotypic genera from mid-Cretaceous Burmese amber, representing the first and the latest record of Procercopidae in Mesozoic ambers, which greatly widens the family's biogeographic distribution.

In addition, Sinoalidae, another typical extinct representative of Cercopoidea, includes 14 species in 10 genera, but is only recorded from the Middle to Upper Jurassic of northeastern China, and from mid-Cretaceous Burmese amber. Sinoalidae differs distinctly from Procercopidae by having hind wings without a submarginal vein, and hind tibia with two rows of lateral spines. The new find describes three new species attributed to two genera of Sinoalids from Burmese amber. One of the key specimens displays an enigmatic combination of features belonging to the Sinoalidae (e.g., hind tibia with two rows of

POSTERS

spines) and modern cercopoids (e.g., antenna unarticulated), providing good evidence that helps reconstruct the evolutionary history of the Cercopoidea. Interestingly, some taxa from the Middle to Upper Jurassic Yanliao Biota have persisted and can also be found in Burmese amber, 65 million years later, yet have never been found in the Early Cretaceous Jehol biota. This temporal persistence probably reveals a biogeogaphic migration route after an ecosystem collapse during the Late Jurassic of North China.

TALKS

POSTERS

Neuroptera as an ideal group to study the evolution of larval traits in holometabolan insects

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Due to new palaeontological findings, it is getting increasingly evident that the greater diversity and disparity exhibited by adult Neuroptera (lacewings, antlions, and their relatives) during the Mesozoic was also true as well for their larval counterparts. The recently described neuropteran larval diversity from Cretaceous amber includes some bizarre, highly specialised forms from ~99 Ma (earliest Cenomanian) Burmese amber and other deposits from Lebanon and Spain. Some green lacewing (Chrysopidae) larvae are debris-carriers, selecting and carrying exogenous elements for camouflage and physical protection. Two debris-carrying chrysopoid species were recently described from ~127 Ma (Barremian) Lebanese amber. First, *Tragichrysa ovoruptora* Pérez-de la Fuente, Engel, Azar & Peñalver, 2018 is a first instar described from multiple neonates preserved together with the egg shells from which they hatched and the structures that were used to crack the egg chorions, or egg bursters. This finding represents the first time that egg bursters have been confidently identified in the metazoan fossil record and that the hatching mechanism of a long-extinct organism has been determined based on direct evidence. Second, *Tyruschrysa melqart* Pérez-de la Fuente, Peñalver, Azar & Engel, 2018 is a late instar associated with debris-packet remains interpreted as fragments of soil. Unlike modern representatives, both Lebanese amber species have extremely elongate setose tubercles dorsally for retaining debris. In T. *melqart*, which is yet another specialization aimed at carrying debris absent in extant chrysopids, the tubercle setae have expanded endings that are mushroom-shaped and which acted as anchoring points. On the other hand, three new straight-jawed larval morphotypes are known from ~105 Ma (late Albian) Spanish amber: one larva is a late instar beaded lacewing (Berothidae) remarkably closely resembling modern relatives, whereas another larval specimen has unclear affiliations between Mantispoidea and Dilaroidea, and displays some potentially apomorphic characters such as last antennal article expanding distally (cowbell shaped), one of the six stemmata on each ocular tubercle that is bar-shaped, and thoracic dorsal sclerites bearing comb-like rows of peg-like short setae on their posterior margin. Unlike most of the other holometabolan groups, neuropteran larvae are typically terrestrial and active as predators. That explains their high relative abundance as amber inclusions. Furthermore, their usual campodeiform bodies ensure that a high number of external characters are potentially available for assessment. Overall, Neuroptera are an ideal group to tackle how morphological, ecological, and behavioural traits evolved in larval holometabolous insects, and so their larval stages are worthy of increased palaeontological research.

The insect Konservat-Lagerstatte of the Upper Carboniferous of Avion (France): an exceptional geoheritage

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TALKS

The spoil tips ("terrils") of coal mines are very visible components of the landscape of the 'Hauts-de-France' region in France. Some are protected for the particular flora and fauna that currently colonize them. They are also very important for their paleontological content. In the UK, some spoil tips have been extensively investigated thanks to active collaborations between researchers and amateur associations (e.g. Writhlington, Jarzembowski, 2004). Similar operations never occurred in France. However, thanks to the active researches of two of us (JO and PR), we were recently able to recover and study a fossil entomofauna of crucial interest. Insects (mainly isolated wings) were recovered in pieces of rock from a layer with an impressive concentration of plant fragments (leaves, stems, etc.). Although some are very large, the great majority of them are less than 10 mm long. Between 2010 and 2019, we found representatives of Paleodictyoptera, Odonatoptera, Archaeorthoptera (including the oldest Titanoptera), Paoliida, Dictyoptera, a stem group of Plecoptera, 'Grylloblattodea', Acercaria, and Holometabola (Nel et al., 2013) on a terril (spoil tip) in the vicinity of Avion, with coal mine debris attributed to Moscovian age. Fossils of these two last clades consist of very small wings, 2-5 mm long and are the oldest representatives of Psocodea, Thripida, Hemiptera, a stem group of Hymenoptera, Mecopterida, and possibly Neuropterida. These subclades are each represented by one fossil, except for the Hemiptera (two Euhemiptera), as well as the oldest fossil Sternorrhyncha, newly discovered. Thus they are much less frequent than the other paleopteran and polyneopteran clades. The fossils from this site are crucial for dating the major insect clades. They also demonstrate that the Holometabola appeared and began to diversify into their modern subclades well before their major Triassic radiation.

POSTERS

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TALKS

POSTERS

The Daohugou entomofauna: stories hidden in rocks

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The Middle-Late Jurassic Daohugou biota contains an incredible array of exceptionally preserved fossils, including insects, diplurans, clam shrimps, fairy shrimps, cladocerans, spiders, harvestmen, millipedes, bivalves, salamanders, lizards, pterosaurs, dinosaurs, mammals, algae, plants, pollen, spores, and fungi. Insects from the Daohugou entomofauna are very diverse, comprising at least 24 orders: Archeognatha, Ephemeroptera, Odonata, Plecoptera, Blattodea, Grylloblattodea, Dermaptera, Orthoptera, Mantophasmatodea, Phasmatodea, Embiida, Thripida, Hemiptera, Megaloptera, Raphidioptera, Neuroptera, Coleoptera, Mecoptera, Siphonaptera, Diptera, Trichoptera, Lepidoptera, Hymenoptera, and the extinct order Permopsocida. Most of the published insect fossils from Daohugou were collected by farmers, and thus the relationship of bedding layers remains elusive. Moreover, the mixed insect assemblage may bear enough general evolutionary significance, but not much information about paleoecosystems.

In recent years, we have used branchiopod fossils as markers to define key subdivisions of the Daohugou beds (Haifanggou Formation). Isotopic dating has been performed on major volcanic layers of the Daohugou beds. Therefore, the bedding sequences of various quarries have become increasingly clear. On the basis of the above analyses, we can clearly define several significant layers and understand the rise of altitude from an initial plain to a 2000-meter-high mountainous environment.

Dragonflies (Insecta: Odonata) in amber: large insects in wet forest

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Odonatans are generally rare as amber inclusions, but one of the most exciting discoveries of the past few years has been the recovery of numerous odonatans (over 340) in mid-Cretaceous Burmese amber, including the aquatic larval stages as well as flying adults. This is the most abundant assemblage found until now and is taxonomically diverse with 34 species in 28 genera and some 16 families. True damselflies (zygopterans) are especially common. Some of the odonatan taxa also have a fossil record as adpressions. More new species will be described in the future, especially rare ones, despite amber production in Myanmar having been adversely affected by the domestic situation.

Closer to the Dominican Republic, odonatans have also been found recently in Miocene Mexican amber. They belong to recent genera, in contrast to those in Burmese amber which represent a more ancient fauna.

In both regions, these 'bird-watcher's insects' were part of a rich biota living under a warm climate in the vicinity of a resinous woodland, coniferous in Burma but angiospermous in Mexico. Amber finds are already augmenting the traditional 'rock' fossil record of these insects.

TALKS

POSTERS

Cicada nymphs (Hemiptera: Cicadoidea) from mid-Cretaceous Burmese amber

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Cicada nymphs (Hemiptera: Cicadoidea: Cicadidae and Tettigarctidae) are important soil organisms, and are famous for their exceptional life cycle and remarkable behaviors, particularly their xylem root-feeding and extremely aggressive fossorial behaviors. The nymphs generally spend many years living underground (and for 'periodical' cicada nymphs, as many as 13 to 17 years). The long period of time underground enables the nymphs to interact significantly with their host plants and unceasingly expose them to a great variety of microbes. This and other behaviors provide us with an avenue to better understand the relationship between the nymphs and the ecosystem. Here we first document three different exuviae, and one final-instar nymph fossil of Cicadoidea from mid-Cretaceous Burmese amber. Major similarities shared by final-instar nymph fossils and extant nymphs of Cicadoidea, for example, include enlarged forelegs, long piercing-sucking mouthparts, conspicuous wing buds, and large compound eyes. These remarkably similar characteristics suggest that an extremely slow rate of morphological change has occurred over time, which may be due to the persistence of a particular lifestyle, as well as similar ecological environments to those of modern species. Additionally, these fossils shed light on the ecology and biology of the early cicada nymphs, and their key morphological features are of significance for understanding the phylogenetic relationships within the diverse group Cicadoidea.

The planthopper family Mimarachnidae (Hemiptera: Fulgoromorpha) and its diversity in Burmese amber

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Planthoppers (Fulgoromorpha) display enormous diversity with 30 extant and extinct families currently recognized. Mimarachnidae Shcherbakov, 2007 is one of the extinct families, characterized by its simplified venation, setigerous metatibial pecten, and spider-like dark silhouette with black eyespots of tegmina (Shcherbakov 2007). Mimarachnidae were already well known from compression/impression fossils in sedimentary deposits of Buryatia (Russia), Japan and Spain (some taxa that are not formally described have been found in Mongolia and probably also in Brazil). In addition, some representatives of this family are preserved as inclusions in mid-Cretaceous Burmese amber, discussed in recent studies (Szwedo 2008; Szwedo & Ansorge 2015; Emeljanov & Shcherbakov 2018; Jiang, Szwedo & Wang, 2018; Zhang, Ren & Yao 2018). The distribution of the family is from the Early to mid-Cretaceous, and spreading from regions of high latitude to tropical paleoequatorial regions according to the latest fossil records.

Moreover, the taxonomic and morphological diversity of fossil Mimarachnidae found in Burmese amber far exceeds that of all the compression/impression mimarachnid fossils recovered elsewhere. The recent described genera have already displayed significant morphological disparity, with derived features like an elongated head in *Jaculistilus* Zhang, Ren & Yao, 2018, giant size in *Dachibangus* Jiang, Szwedo & Wang, 2018, and a rostrum reaching beyond the abdomen in *Burmissus* Shcherbakov, 2017. Taxonomic diversity of these fossils allows us to erect a number of new taxa at specific, generic and even higher levels. However, the relationships of the Mimarachnidae within the Fulgoromorpha clade are not fully understood. Although our recent discoveries contest the findings of earlier studies regarding the relationships between Mimarachnidae and Neazoniidae, a set of new questions has arisen, and the possibility of new explanations for the Fulgoromorpha phylogeny and interrelationships will require further study.

This extinct family also offers an unprecedented opportunity to observe morphological adaptations for sophisticated camouflage, with eco-morphological traits like flatoidinisation and laternarisation present in some modern planthoppers as well. The study of Mimarachnidae provides exceptional and unexpected insights into not only the evolution of Cretaceous planthoppers, but also their eco-evolutionary adaptation.

New family – unknown evolutionary line of Tipulomorpha (Diptera, Nematocera)

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Tipulomorpha is a very large group of insects, distributed worldwide, and is one of the most important groups among the Nematocera. Tipulomorpha are characterized by a relatively high diversity of species, wide adaptive radiation, and a diversity of interactions among communities, sometimes playing a significant role in ecosystems. This group of insects is characterized by a number of plesiomorphic features, such as a low degree of oligomerization, small costalisation of a wing, and primitive morphology of larva. The infraorder comprises families including Limoniidae, Cylindrotomidae, Tipulidae, Gnomuscidae, Psychotipidae and Archilimoniidae. The families Trichoceridae, Limoniidae, Cylindrotomidae and Tipulidae are for the most part represented both in the fossil record and in recent fauna. Since the Triassic, the body morphology of these insects has evolved. The copulatory apparatus of one particular group of Tipulomorpha is quite differentiated, and tipulamorphs also display a wide range of morphological adaptations of antenna, palpus, and wing venation. It is significant that representatives of a new family of Tipulomorpha from Eocene Baltic amber exhibit scales on the wing membrane and along veins of the wing. These structures are similar to the scales seen along the wing veins of Culicidae, but with a venation pattern typical of Tipulomorpha. No other members of the various families in Tipulomorpha exhibit these scales.

TALKS

POSTERS

Extinct Trogossitidae (Coleoptera) from the Pacific islands

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Our research demonstrates that islands in eastern Polynesia had been inhabited by a rich endemic insect fauna, and that the arrival of humans likely had a catastrophic impact on indigenous species. During sifting of sediments from pits, 3 to 5 m deep, we found and identified fragments of six new species of the trogossitid beetles. The age of samples is estimated to be 1,500 to 4,500 years before the present. These now extinct species were restricted to five isolated islands of the Cook, Austral and Society Island chains. Only one of the islands was inhabited by two species of this taxonomic group. In contrast to their continental relatives from the tribe Trogossitini, they were wingless, and two of them tended to gigantism. One extant new species of the group has been recently discovered in Tahiti. Although the nearest members of Trogossitini are known from Fiji, a molecular analysis based on four genes reveals a surprising relationship between the extant species and Central American fauna. We put the Tahitian species into a 4-gene data matrix comprising 160 cleroids and counted split-events in Cleroidea using a molecular clock calibrated with all known cleroid fossils from the Mesozoic and Cenozoic. The deepest estimated break-off for the Pacific group was about 41Ma, in contrast to a much lower age for the Society Islands, thus making the evolution of the newly discovered group appear convoluted. One feasible hypothesis suggests dispersal by Hawaiian biota, which has previously been demonstrated to be a stepping stone for dispersal in the Pacific. Furthermore, the American-Hawaiian-Societies hypothesis is supported by the significantly greater geological age of the Hawaiian Islands amongst other Pacific archipelagos. There is one more insular, probably recently extinct group of the trogossitid beetles, the genus *Antillipeltis* Lawrence et al., known from two Caribbean islands. Six species have been recently distributed in the Dominican Republic, Haiti and Puerto Rico, and two fossil species are known from Dominican amber. Although all attempts to find the species have been unsuccessful over the past 100 years, it may still be possible to discover some of them in Hispaniola or adjacent islands.

Evolution of the infraorder Tipulomorpha (Diptera) in the Mesozoic

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Infraorder Tipulomorpha (Diptera) contains five extant families: Cylindrotomiidae, Limoniidae, Pediciidae, Tipulidae, and Trichoceridae, and three extinct families known only from the Triassic: Archilimoniidae, Gnomuscidae, and Psychotipidae. Currently the infraorder is very numerous. There are about 15.000 already described species. Tipulomorpha are distributed in all continents, including one recent invasive species of *Trichocera* in Antarctica.

Triassic Tipulomorpha fossils are very rare. A rapid radiation of this group occurred at the turn of the Triassic to the Jurassic. As a result, currently represented families (Limoniidae, Pediciidae, Tipulidae and Trichoceridae) first appeared in the Jurassic. Cylindrotomidae first occurred much later. In the Jurassic and Lower Cretaceous, the Limoniidae are represented by a large number of species from two fossil subfamilies, Architipuliinae and Eotipulinae, which are known mainly from Gondwanan deposits. After these two subfamilies became extinct, they were replaced by the extant Limoniidae subfamilies. The families Pedicidae and Tipulidae are very rare during this period.

TALKS

POSTERS

A new family of orussomorph wasps from Cretaceous Burmese amber

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Orussomorpha is a small group of Hymenoptera sharing the features of two major hymenopteran lineages: sawflies (Symphyta) and wasps (Apocrita). Being formally assigned to Symphyta based on its abdominal structure, Orussomorpha displays numerous apocritan apomorphies, such as a parasitic lifestyle, flexible articulation between 1-st and 2-nd abdominal segments, and reduced wing venation. Being a transitional form between Symphyta and Apocrita, Orussomorpha is essential for understanding the origins of Apocrita – the most diverse and abundant hymenopteran lineage. In the Extant Fauna, Orussomorpha is represented solely by the family Orussidae with few fossil records: only two specimens described from the Cretaceous and two others from the Cenozoic. However, two extinct orussomorph families, namely Karatavitidae and Paroryssidae, are rather abundant, known from the Jurassic and Cretaceous.

Examining the Burmese amber collections of Nanjing Institute of Geology and Paleontology, Chinese Academy of Sciences, we revealed two specimens of enigmatic wasps having one of the most striking Orussidae features – an ocellar corona (two rows of backward-pointed teeth around the middle ocellus). However, differences in wing venation, 14-segmented antennae attached high above clypeus, and other characters suggest that these two specimens strongly differ from other orussomorph families and should be assigned to a new family within Orussomorpha.

Our cladistic analysis shows that the new family is the sister group to Orussoidea (Orussidae + Paroryssidae), and that they, forming a monophyletic group, further become a sister towards Apocrita.

The two specimens, one of which is the best preserved orussomorph fossil, reveal some morphological characters unknown from other fossils of this group: all legs bearing prominent lanceolate lobes on the 3rd tarsomeres. A similar structure serves as a part of the vibration sensor in Orussidae and Stephanidae, but is located only in fore (Orussidae) or hind (Stephanidae) legs. Based on the presence of a vibration analyzer used for host search inside wood, we suspect that the new Burmese wasps were the wood-host parasites, much like extant orussids.

The new findings are also important for confirmation of the "size reduction hypothesis", proposed by Rasnitsyn (1969, 1980) and discussed by Vilhelmsen (2004). According to this hypothesis, the ancestors of Apocrita underwent a considerable size reduction. The tiny size of the new orussomorph fossils (body length ~2.5 mm) can be regarded as indirect evidence of the size reduction hypothesis.

TALKS

Blephariceridae: origin of the family and evolution of wing venation (Diptera, Nematocera)

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Blephariceridae are a small dipteran family with c. 300 species living in montane regions of all continents except Antarctica. The larvae inhabit mountain creeks with fast flowing, well oxygenated waters. Wings of most species are endowed with a dense net of secondary, delicate pseudo-veins specifically characteristic to this family and no other. The basic venation in recent species is already greatly reduced. The most complete venation pattern is found in the recent genus *Edwardsina* from South America and Australia. Fossil species are scarce, known from the Upper Jurassic and Lower Cretaceous; their venation helps to reconstruct the evolution of this exceptional and very interesting family and to understand the mechanisms involved in the reduction of venation in particular, particularly among geographically isolated populations/species.

POSTERS

Mesozoic Palaeontinids (Insecta, Hemiptera) from UK and China

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Palaeontinidae is an extinct family of hemipterous insects known from Triassic to mid-Cretaceous fossils. It was originally placed in the order Lepidoptera, and later transferred to Homoptera (Hemiptera) by Tillyard (1921). So far, Cretaceous palaeontinids, belonging to 30 species within 12 genera, have been discovered in Spain, Russia, China, England and Brazil. The early Cretaceous palaeontinids from Europe are mainly reported from Spain and England. During the past 20 years, abundant and well-preserved palaeontinids have been described from Middle Jurassic and Lower Cretaceous of China. Ten species within five genera have been reported from the Lower Cretaceous of northern China.

Four new species from the UK and China were described (Li et al. 2019a, b). V*aldicossus mikewebsteri* Li *et al*., 2019 is from a new palaeontinid locality: Smokejacks brickworks in southern England, and includes the first complete hindwing of a Palaeontinidae from the UK. *Ilerdocossus prowsei* Li *et al*., 2019 is based on a well-preserved forewing from the former Clock House Brickworks, also in southern England. *Ilerdocossus dissidens* Li et al., 2018 and *Miracossus gongi* Li *et al*., 2019, are collected from the Lower Cretaceous Yixian Formation of Inner Mongolia and western Liaoning. I. *dissidens* Li *et al.* is different from other species of the genus in possessing a forewing with outer margin dentate; vein M1+2 bifurcating distal of the level of indentation; M3+4 bifurcating basal of the level of indentation; vein CuA1 slightly curved anteriorly; branch CuA2 curved posteriorly then recurved. *M. gongi* Li *et al*., 2019, is different from the type species in having a smaller forewing with different color patterns.

Li, Y.L., Chen, J. and Wang, B. 2019a. New Cretaceous palaeontinids (Insecta, Hemiptera) from northeast China. *Cretaceous Research*, **95:** 130–137. Li, Y., Jarzembowski, E., Chen, J. and Wang, B. 2019b. New Palaeontinidae (Insecta: Hemiptera) from the Lower Cretaceous of southern England. *Cretaceous Research*, **95:** 297–301.

TALKS

POSTERS

Progress on the study of Ephemeroptera from mid-Cretaceous Myanmar amber

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In recent years, many insect groups have been discovered and described from mid-Cretaceous Myanmar (Burmese) amber. However, only five genera and five species of Ephemeroptera (mayflies) in Myanmar amber have been recorded hitherto. According to the classification of Ephemeroptera by Kluge (2004), all extant families and almost all Mesozoic and Cenozoic mayflies are from the suborder Euplectoptera, which is divided into two infra-orders: Anteritorna and Posteritorna. The first mayfly described from Myanmar amber is *Myanmarella rossi* Sinitshenkova, 2000, which was originally regarded as the first fossil Prosopistomatidae in Anteritorna for having an enlarged pedicel, weak additional longitudinal veins and few cross-veins. But, the line drawing and description of wings show the typical characters found in Baetidae in Posteritorna: iMA, MA2 and iMP, MP2 not connected with MA1 and MP1, CuP basally curved and strongly diverged from CuA, paracercus absent, and most importantly, CuP vein posterior to tornus. These wing characters indicate that *Myanmarella rossi* Sinitshenkova, 2000 should be attributed to Baetidae rather than Prosopistomatidae. Recently, the first true fossil record of Prosopistomatidae was recovered from Myanmar amber: P*roximicorneus rectivenius* Lin, Shih & Ren, 2018 and provides the evidence that Prosopistomatidae might have originated from Laurasia rather than Gondwanaland. However, fossils of another family in Anteritorna, Baetiscidae, were found in Brazil (Lower Cretaceous) and Baltic amber. Therefore, more new fossils are needed to clarify the origin of Anteritorna. In addition, there are three species recovered from Myanmar amber attributed to another infra-order: Posteritorna, which are *Vetuformosa buckleyi* Poinar, 2011 of Baetidae with primary ovipositor, *Nanophemera myanmarensis* McCafferty & Santiago-Blay, 2008 of the extinct family Australiphemeridae, and *Hexameropsis elongatus* Lin, Shih & Ren, 2018 of the extinct family Hexagenitidae, with elongated abdominal sternum IX. It's hard to identify subimagos in compression fossils. But well-preserved amber subimagos can provide some evidence for identification. Newly discovered mayflies in Myanmar amber have enabled us to identify subimagos by wing features, e.g. posterior margin of forewings and hind wings fringed with long setae, and wing surface fulfilled with obvious granular tubercles.

TALKS

POSTERS

Palaeodiversity of snakeflies (Insecta: Raphidioptera) from the mid-Cretaceous of Myanmar

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Raphidioptera (snakeflies) is a holometabolous order of the superorder Neuropterida characterized by a distinct narrowly elongated adult prothorax and a long female ovipositor. Mesozoic snakeflies were markedly more diverse than modern ones are. However, the evolutionary history of Raphidioptera is largely unexplored. Here we report a diverse paleofauna of snakeflies from the mid-Cretaceous of Myanmar. Baissopteridae is recorded for the first time in Burmese amber, with nine new species in six genera (five of them are new genera). Mesoraphidiidae comprise nine species in eight genera, with four genera and four species new to science. The various species display remarkably diverse morphological modifications, such as a strongly elongated antenna, a posteriorly neck-like occiput, an enlarged forewing pterostigma, and a specialized tarsomere 3, etc. Moreover, the genital morphology, which was previously poorly known for extinct snakefly families, is herein studied based on well preserved specimens. The present findings highlight the paleodiversity of Cretaceous snakeflies and provide important evidence for understanding the evolution of Raphidioptera.

Same same but different – rhopalosomatid wasps in mid-Cretaceous and Miocene amber (Hymenoptera: Rhopalosomatidae)

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Rhopalosomatidae are a family of aculeate wasps that as larvae are ectoparasitoids of crickets (Orthoptera: Grylloidea). The family comprises less than a hundred species and is found in the tropics and subtropics of all continents except Europe and Antarctica. Whereas some species resemble nocturnal Ichneumonidae, others might be mistaken for spider wasps or different groups of brachypterous Hymenoptera. Although the published fossil record of the family is scarce, the ongoing revision of the fossil rhopalosomatids has revealed almost 50 new fossil specimens from Dominican, Mexican, and Burmese amber. These fossils not only include the first records of the extant genus *Rhopalosoma* in Miocene amber, but also a relative abundant and diverse assemblage in mid-Cretaceous Burmese amber, incl. the first record of a fossil rhopalosomatid larva attached to its cricket host. These Cretaceous fossils reveal considerable constancy in the general larval and adult morphology and behavioral specialization of Rhopalosomatidae over the last 100 million years.

TALKS

POSTERS

Contribution to the knowledge of Lower Cretaceous lepidopterans in Spanish amber, likely belonging to Micropterix and *Sabatinca* (Micropterigidae)

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Paleoentomological research on Spanish amber began in 1995 when abundant and diverse bioinclusions were found in amber excavated from the Sierra de Cantabria (in northern Spain). Since then, Spanish amber sites have been widely studied, and these studies continue today, carried out by multidisciplinary and international teams. At present, around 150 Lower Cretaceous amber-bearing sites have been catalogued. The fossil lepidopterans discovered (26 thus far) came from the outcrops of Peñacerrada I (Moraza, Burgos) (22), and El Soplao (Rábago, Cantabria) (4), which were located in the north of the Iberian Plate during the Cretaceous, in the east margin of the Basque-Cantabrian Basin. The outcrops are Upper Albian in age (*ca*. 105 Ma), and the amber is associated with coal from plant material deposited in deltaic environments.

Among the arthropods, hexapods are the dominant group, with 15 orders being recognized to date in Peñacerrada I and 13 in El Soplao. The most abundant and diverse insect groups are dipterans and hymenopterans, comprising 61-65% of all hexapods found. The lepidopteran record is rather humble; so far, only 22 moths have been found in Peñacerrada I (1.22%), and four in El Soplao (0.73%). El Soplao specimens are jaw-moths of the family Micropterigidae, and one of these is *Micropterix* Hübner, 1825, found in a piece of amber that also includes (likely) Schizaeaceae fern spores; the other three might be *Sabatinca* Walker, 1863, but their wing venations are obscured by debris and will require further study. Peñacerrada I specimens include 21 micropterigids, likely conspecific, which we have included in the genus *Sabatinca*. The 22nd specimen seems to be a Glossatan Tineoidea, although its assignation is uncertain since its head and thorax are lacking. Their descriptions are still pending.

Micropterigids include pre-angiosperm moths, and are considered the most primitive extant lineage of Lepidoptera, remaining essentially unchanged since the Early Cretaceous and containing currently about 20 living genera / 260 species. The earliest indisputable fossil micropterigid, perfectly preserved in Barremian Lebanese amber, is datable to about 130 Ma; followed later by the Spanish specimens (*ca*. 105 Ma), and then those of Myanmar (Cenomanian in age, *ca*. 99 Ma).

Extant larval micropterigids are dependent mainly on liverworts, and then as adults on fern spores or (in a few cases) angiosperm pollen. The palynological fossil record of the Basque-Cantabrian Basin suggests that the resin was produced in subtropical forests which developed under a seasonal wet-dry climate and were inhabited by ferns, gymnosperms (the conifers that dominated this forest, mainly araucariaceans and cheirolepidiaceans) and early angiosperms.

Discovery of a New Fossil Species of New World Resin Assassin Bugs (Heteroptera: Reduviidae: Apiomerinae: Apiomerini: Apicrenus) from Dominican amber

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TALKS

This work reports on the discovery of the second known fossil species of the genus *Apicrenus* Maldonado Capriles, Santiago-Blay & Poinar, 1993 in Dominican amber, and compares it to related genera and species. The new fossil species is described based on a well-preserved male specimen embedded in a cubic piece of clear amber originating from the Yanigua formation in the region of Los Haitises, northeastern Dominican Republic.

The fossil is believed to be a member of the genus *Apicrenus* based on its overall shape and the morphology of its head, pronotum and legs, which are like those of *A. fossilis*. Distinguishing features of the new species will be analyzed and discussed. The availability of another fossil Apiomerini should enhance attempts to answer questions related to the early evolution of the group.

New World resin assassin bugs of the subfamily Apiomerinae tribe Apiomerini coat their front legs and the female ventral abdominal area with resins to facilitate capturing prey and for maternal care behaviors. They comprise about 160 species in 12 extant genera plus one fossil in Dominican amber. Their distribution ranges from Canada to Argentina. At present times, only three species of Apiomerini are known to inhabit the insular Caribbean, none in Hispaniola. Morphologically the Apiomerini are characterized by having a sulcus or a notch on the apex of the protibia for reception of the tarsi.

POSTERS

Apicrenus fossilis Maldonado Capriles, Santiago-Blay & Poinar, 1993 was described from a fossil piece from La Toca mine (Cordillera Septentrional) in northern Dominican Republic. The genus *Apiomerus* sp. has also been identified as present among fossils in Dominican amber (Poinar & Poinar, 1999). *Apiomerus* is currently the most speciose genus in the tribe with some 110 species.

This discovery supports the idea that the diversity of Apiomerini in the Greater Antillean area during Miocene times was greater than at present. The known diversity of fossil assassin bugs (Reduviidae) in Dominican amber comprises 13 species in 11 genera and 5 subfamilies. This relatively high number of fossil species denotes the close association of many assassin bugs to resins, hence increasing their probability of becoming entrapped and fossilized.

TALKS

POSTERS

Were beetles (Insecta: Coleoptera) bugging resin-producing plants during the Cretaceous?

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Amber is a significant source of information about ancient forest and woodland ecosystems. The concentration of large amounts of resin from the Cretaceous to the Present has been explained by different abiotic and biotic events such as wildfires, hurricanes, volcanism and pests (Martínez-Delclòs et al., 2004; Labandeira, 2014; Peris et al., 2016; Seyfullah et al., 2018). Beetles were historically considered as one of the main causes of resin production in ancient forests. This interpretation is probably attributable to: (1) the abundance of wood-boring beetles, such as Platypodinae and Scolytinae, described in Mexican and Dominican Miocene ambers (Bright and Poinar, 1994), and (2) a lack of in-depth knowledge of the beetles from the Cretaceous amber collections worldwide. After an increase of researches focused on fossil beetles preserved in Cretaceous ambers, families found there shared with their modern relatives saproxylic and detritivorous habits at larval or adult stage, rather than wood-boring behaviors. The Miocene Mexican and Dominican ambers were produced by resiniferous angiosperms (*Hymenaea* spp.) and their fossil assemblages of scolytines and platypodines probably represent beetles that used these plant species as hosts, damaging the trees and inducing the resin production (Peris et al., 2015). However, resin producers of Cretaceous ambers worldwide were gymnosperms, and although xylophagous beetle groups, such as Ptinidae, Bostrichidae, Brentidae, and Scolytinae are already recorded in these ambers (Peris, 2016), they are always isolated occurrences, a record that is not indicative of pest episodes. Thus, based on diverse evidence, infestation by beetles was not the most likely cause of resin production during the Cretaceous.

Acknowledgements

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New Cretaceous records and the diversification of crown-group ants (Hymenoptera: Formicidae)

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The knowledge on Cretaceous ants has significantly improved within the last decade, thanks to increasing discoveries from insect-rich amber deposits. Yet, the vast majority of fossils found preserved in Cretaceous deposits belongs to extinct, stem-group ants such as the Sphecomyrminae and Brownimeciinae. To date, only nine species in eight genera have been attributed to crown-group ants. Among these, however, *Burmomyrma rossi* Dlussky, 1996 should be excluded from Formicidae and transferred to Falsiformicidae (Chrysidoidea). Also, the placement of three species from Campanian Canadian amber is still debatable: *Canapone dentata* Dlussky, 1999, originally placed in Ponerinae and later transferred to Ectatomminae; *Eotapinoma macalpini* Dlussky, 1999 in Dolichoderinae; and *Cananeuretus occidentalis* Engel & Grimaldi, 2005 in Aneuretinae. The three species were each based on a unique specimen that was only partial or partly visible, two of which have been lost, and their precise affinity remains enigmatic. Similarly, imprint fossils from the Turonian of Botswana, that were tentatively placed in Ponerinae (*Afropone oculata* and *A. orapa* Dlussky, Brothers & Rasnitsyn, 2004) and Myrmicinae (*Afromyrma petrosa* Dlussky, Brothers & Rasnitsyn, 2004), were based on poorly preserved specimens and assignment to these subfamilies has been questioned. Finally, only two of the nine described species are definitely assignable to extant subfamilies: *Kyromyrma neffi* Grimaldi & Agosti, 2000, a Formicinae from Turonian Raritan amber; and *Chronomyrmex medicinehatensis* McKellar, Glasier & Engel, 2013, a Dolichoderinae from Canadian amber. Here I present six new morphotypes from Burmese amber that are assignable to crown ants: a Ponerinae, a Formicinae, and a Dolichoderinae in early Cenomanian amber from Northern Myanmar ('Kachin amber'); and a Ponerine and two Dolichoderinae in late Campanian amber from Central Myanmar ('Tilin amber'). These records greatly expand the known diversity of Cretaceous crown ants, and shed a new light on the origin and early diversification of extant ant subfamilies prior to their great Cenozoic expansion.

Phylogeny of the basal Odonatoptera (Insecta) from the Lower Carboniferous (Serpukhovian) of Central Western Argentina

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The aim of the work is to propose a phylogeny of the Odonatoptera basal to Paneodonatoptera, based on wing characters. These basal odonatopterans correspond to five genera from the Lower Carboniferous, upper Serpukhovian (325-324 Ma) from La Rioja Province, Central West Argentina. Genera *Eugeropteron* and *Geropteron* come from Malanzán Formation, and genera *Tupacsala, Argentinala* and *Kirchnerala* come from Guandacol Formation. These formations are considered lateral equivalents of two neighbouring basins dominated by glacial events. Together with two other species of Xenopteraidae (Megasecoptera), this is the oldest diverse entomofauna with flying insects worldwide. Coincidentally with their antiquity, these basal Hydropalaeoptera recorded in the boundaries of the Hexapoda gap (325 Ma) share some plesiomorphies unique among insects, such as having radial sectors completely separated. Both sectors RA and RP are convex (+), being interpreted as the RP fused with the MA from the base of the wing. RP is convex while it is fused with MA, becoming concave (-) after arising of the latter. MA arises with a strong Z-shaped kink, which seems to operate as a flight device, analogous with the arculus in the Odonata crown group. In the latter group, all three veins (RA+RP+MA) run basally to the arculus together in a convex (+) triple stem. Another ground plan simplesiomorphy is the MP bending anteriorly, separated or fused but not "captured" by the CuA. The Paneodonatoptera share the MP bending posteriorly and fused, "captured" by the CuA, a synapomorphy obscured in the Odonata crown group. *Argentinala* has also six wings, with veined and possibly movable prothoracic wings; characters unique within Odonatoptera. The analysis sheds light on the genealogical relationships of these basal taxa of Odonatoptera and coincides with the classification of Petrulevičius and Gutiérrez (2016). It shows the paraphyly of Eugeropteridae *sensu* Riek (1983) and Geroptera *sensu* Brodsky (1994) and Kukalová-Peck (2009). Bechly et al. (2001) warned that the monophyly of Geroptera was weakly founded. The most important morphological changes in wing venation in these basal groups go through the fusion of veins, principally in the medial, cubital and anal systems. The phylogeny resulted in Odonatoptera including Eugeroptera (Eugeropteridae: *Eugeropteron lunatum* Riek, 1983 and *Tupacsala niunamenos* Petrulevičius and Gutiérrez, 2016) and Palaeodonatoptera. Palaeodonatoptera including Kukaloptera (Kirchneralidae: *Kirchnerala treintamil* Petrulevičius and Gutiérrez, 2016) and Plesiodonatoptera. Plesiodonatoptera including Argentinoptera (Argentinalidae: *Argentinala cristinae* Petrulevičius and Gutiérrez, 2016) and Apodonatoptera. Apodonatoptera including Geroptera (Geropteridae: *Geropteron arcuatum* Riek, 1984) and Paneodonatoptera.

TALKS

POSTERS

Palaeodictyoptera: new clues to the origin of insect wings

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The acquisition of wings, along with holometabolous development, are individually and together considered to be among the most important evolutionary novelties which fueled the rapid diversification of insects. However, the origin of insect wings remains a fiercely debated topic in evolutionary biology and has spawned numerous hypotheses over the last 150 years. The recently proposed 'dual model' for insect wing origins represents a synergy of the epicoxal and more traditional paranotal hypotheses, and considers the thoracic-tergal edge as the source from which the wing blade structure (the flight foil) arose, with the articulation derived genetically from the proximo-dorsal part of the arthropod leg relating to the development of an articulating joint. Evo-devo studies support the participation of the two genetic domains in the formation of the wing.

Our study has revealed new details on wing pad joints of Paleozoic Paleodictyoptera, observable on the three pairs of wing pads from exceptionally well-preserved Carboniferous nymphs. These wing pads were medially articulated to the thorax by associated sclerites, but also markedly fused with the notum anteriorly and posteriorly, supporting the dual model for insect wing origins. Furthermore, the reconstructed structure of the wing base in adults of the paleodictyopteran genus *Dunbaria* (Spilapteridae) reveals a prominent upright axillary plate with presumable position of 3Ax and a markedly reduced humeral plate.

Finally, these new results reveal the homologous structural elements between extinct Paleodictyoptera and their extant relatives among the Ephemeroptera, Odonata, and Neoptera.

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Fossil resins: history of their forming

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TALKS

Fossil resins (FR) are amorphous complex molecular polymers, widespread on all continents. They are found associated with brown coal deposits, lignite and lignitic clays and other associated sediments. Succinite amber is found in the territory of the Baltic-Dnepr amber-bearing province. This amber is used widely for ornamental jewelry, due to its low fragility and high decorativeness. It is also commonly used in the chemical industry, medicine, and agriculture.

Some of the other various fossil resins share basic physicochemical characteristics with Baltic amber (examples include Burmese amber, Dominican amber, Canadian amber, Japanese amber, etc.). Another group of FR – fragile and not applicable to the making of jewelry, include such ambers as New Jersey amber, Lebanese amber, Spanish amber, and in fact most of the Cretaceous or older fossil resins. Very young resins that have not yet polymerized significantly are called copal, found in recent moist tropical and subtropical forests in Africa, South and Central America, South-east Asia, Australia and Oceania.

Resin excretion by woody plants possibly appeared as early as the Devonian (about 400 Ma), and was certainly taking place as gymnosperms evolved, spread and diversified. This resin production appears to have become significant during the Mesozoic, and especially by the Cretaceous. More recently in the Paleogene and to the present-day, angiospermous trees evolved and also produced resins (e.g., dipterocarps and Hymenaea), which such trees still produce. Interestingly, an as-yet-undetermined conifer (gymnosperm) produced the Baltic amber resin during the Eocene.

POSTERS

Coal and lignite deposits containing amber, which were mostly formed in low-lying coastal areas or in lacustrine settings, are now found in a variety of areas, some presently inland, away from continental margins, resulting in a variety of facies conditions of sedimentation. In various areas of North America, Africa and Eurasia, both primary and allochthonous FR deposits have been found. Amber characteristics are the result of a combination of factors: botanical origin, resin chemistry, and the taphonomic conditions for deposition and fossilization. In the late Eocene to early Oligocene, older sediments containing peat and lignite, and also containing what has come to be known as Baltic amber, were eroded. Redeposition took place in marine and continental conditions. In a low-lying or marine glauconitic environment, the amber probably matured further, perhaps thus fully acquiring its present unique characteristics.

Upper Cretaceous misfits - cirolanid-like isopodans in Burmese amber

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TALKS

Although woodlice seldom are very abundant in amber deposits, either in number of individuals or species, they are present in many localities. Woodlice are representatives of Oniscidea, land-living crustaceans of the larger group Isopoda. While onisciddeans are definitely the most commonly known representatives of Isopoda, most of the species diversity, as well as most of the morphological diversity (≈disparity) of isopodans, is found within their marine representatives. The fossil record of Isopoda dates back to the Upper Carboniferous. However, the majority of isopodan fossils do not allow for a detailed inspection of their morphology, as the fossils are often severely compressed or incomplete, for example caused by the typical biphasic moulting. Their enhanced preservation in amber probably represents the most common exception to this general pattern. Burmese amber (Upper Cretaceous, approximately 99 million years old) yields some of the oldest amber fossils of isopodans. Here we present a new isopodan species from Burmese amber. Yet, judging from its morphological features, this species is not indicative of Oniscidea – the isopodan group with terrestrial representatives. The new species is known from two specimens, representing two different (but not subsequent) ontogenetic stages. The specimens share a unique morphology that attests to their conspecifity, yet ontogenetic modifications can also be observed. This morphology generally matches those of modern representatives of Cirolanidae (Scutocoxifera: Cymothoida). The presence of presumed aquatic isopodans in amber is exceptional, yet not unique. The occurrence of a cirolanid in Eocene Baltic amber, plus recent discoveries of parasitic isopod larvae in Miocene Mexican amber and Cretaceous French amber, as well as many remains of other animals with a presumed aquatic or even marine lifestyle, requires a new discussion about amber taphonomy. Taphonomic features in the presented specimens could contribute to this discussion and help us understand why many amber deposits yield an unexpected and sometimes considerable fraction of aquatic organisms.

POSTERS

Experimenting with resins

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Most people, when they think of amber, think of the organisms preserved inside it. These inclusions can be spectacular, often with fine detail preserved, and they are important to us palaeobiologists. Some fossil resin deposits, like the Baltic amber deposit, are clearly not preserved in situ. This makes it more difficult to reconstruct the source ecosystems from which these inclusions (and the amber) are derived. This is because some potentially helpful information about the source habitat has been lost in these redeposited ambers. Besides the inclusions trapped in amber, there is potential research value in the surrounding amber itself. This can be very useful for ambers that have been transported and redeposited, to help determine the sources (or affiliations) of amber deposits chemically.

Looking at amber from a plant perspective, under what conditions do plants produce resins that may become ambers, and what does this tell us about amber deposits in the fossil record? This is a key question that surrounds the inclusions, like the amber does: What was the state of the habitat that produced these inclusions? This is central to being able to interpret the taxa we discover in amber. So, are these inclusions derived from stable ecosystems, perhaps indicating a long duration of the 'amber source forest' with a steady background of low amounts of resin production? Conversely, are they instead the result of a disturbance (whether more localised or large-scale), perhaps indicating a far shorter time scale, and that the resin production was strongly increased? Could we tell these contrasting conditions apart?

The potential value of amber as a medium for preserving ecological or environmental signals is a developing area. This includes attempts to relate potential biomarkers preserved in amber as signals that might be linked to insect attack or climate to try to answer the stable vs. unstable habitat question. Experiments with resinous plants are helping us to understand what affects resin chemistry and its variability, and whether ambers might be used as a proxy for palaeoatmospheric reconstructions.

Jurassic-Cretaceous Fossil Insects from Northeastern China Elucidate Courtship, Mating, Reproduction and Maternal Care

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All living organisms exhibit a fundamental process in passing their genes to subsequent generations for the continuation of the species. Although numerous studies document the reproductive biology in extant insects, sparse occurrences of well-preserved fossil insects make it difficult to elucidate early developmental and long-term trends of insect courtship, mating, reproduction and maternal care. Well-preserved insect and plant compression fossils from the latest Middle Jurassic Jiulongshan Formation and mid Lower Cretaceous Yixian Formation of Northeastern China provide several new and important morphologies that elucidate the function of insect courtship, mating, reproduction and maternal care. Three Middle Jurassic male scorpionfly specimens with extensively distended abdominal segments and enlarged genitalia display extreme sexual structures. Similarly, several praesiricid sawfly specimens, from the Lower Cretaceous, were discovered with prominently long, sharp mandibles potentially used for sexual display, territorial defense or possibly mate attraction. One Middle Jurassic katydid specimen features an exceptionally well-preserved stridulatory apparatus capable of producing sounds and musicality at low frequencies for attracting potential mates. Analogously, several caddisfly specimens had bipectinate antennae, whereas another sawfly bore feathery antennae, and a third scorpionfly possessed unipectinate antennae for locating potential mates or food sources in their Lower Cretaceous ecosystems. An example of exceptional reproductive stasis is a pair of Middle Jurassic copulating froghoppers indicating constancy in genital symmetry and mating position for over 165 million years. Wasp specimens display exceptionally long ovipositors for laying eggs into their plant and animal hosts. A Lower Cretaceous cockroach group possessing an internally partitioned ootheca provided maternal protection and care for eggs and offspring either to avoid predators' attack or alternatively survival under inclement environmental conditions. Last, a variety of land-plant fossils exhibit three insect functional feeding groups of oviposition, leaf mining and galling that record the early biology of insect larvae. These mid-Mesozoic examples illustrate the profound behaviors and associated structures attendant with a major expansion of insect diversity.

The Cause of fluorescence and origin of Dominican blue amber

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Dominican blue amber displays an exceptional fluorescence triggered by ultraviolet (UV) light. Thus, although blue amber has a yellow body color, it readily fluoresces blue on dark backgrounds and under sunlight, unlike most ambers, which only show fluorescence under a black light. This readily visible fluorescence in blue amber can appear as various shades and intensities of blue (e.g. sky blue, vivid blue, intense blue, purplish blue, light blue, greenish blue). To determine the cause of this heightened fluorescence, we examined a number of specimens of Dominican blue and non-blue amber, as well as amber from various localities in the DR, with FTIR, UV-Visible-spectrometer, Photoluminescence (PL), and traditional jewelry instruments. We then performed analyses on the results obtained. We found some different peaks in this comparison between the blue and non-blue amber spectrum. We also found a significant compound in the amber which we believe is a primary cause of this enhanced fluorescence. Meanwhile, we also determined a method to differentiate the origin of blue amber from distinct localities.

The UV-Visible-spectrometer demonstrated that the amber's fluorescence was related to the organic source of its composition, and allowed us to identify the aromatic hydrocarbon component "perylene" as a major component that contributes to the exceptional fluorescence of Dominican blue amber.

FTIR spectra showed hydroxyl groups and carbonyl groups. The blue varieties of amber contained higher concentrations of CO2, suggesting heating from conflagration and then cooling in water, followed by hardening and extreme polymerization. We also found a significant amount of lignite "in situ" at blue amber mines, noting that the blue amber is typically distributed in the sand and clay sediments with lignite. We also tested the lignite, and our FTIR study indicates the lignite as likely the primary source of the "perylene."

The Photoluminescence indicated that the blue amber absorbs photons transitioning to a higher energy level, then returns to a lower energy state when it releases the photons. Photoluminescence can be classified into fluorescence and phosphorescence according to the delay time. We analyzed the average excitation and emission spectra of molecules for different origins of blue amber.

Testing blue and non-blue amber with the gemological polariscope showed the same basic molecular structure, so it is noted that the molecular structure is not the main cause of its increased fluorescence.

A new genus and subfamily of bibionid fly (Diptera, Bibionidae) from the Lower Cretaceous

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TALKS

The family Bibionidae has traditionally been divided into two main branches: the Bibioninae which have an unforked Radial sector vein and modified fore legs, and the Pleciinae (sensu lato) with forked Radial sector and slender fore legs. In newer classifications, the genus *Penthetria* has frequently been placed in a subfamily of its own, Penthetriinae, and the subfamilies Penthetriinae and Pleciinae include one genus each. Recent molecular data suggest that the genus *Hesperinus* is fairly closely related to *Penthetria*, and should be included with it in the subfamily Hesperininae. We report the finding of a fossil bibionid fly from the Lower Cretaceous of Montsech, Spain which habitually looks similar to Pleciinae, but investigation of phylogenetically relevant characters suggest that it belongs in the branch leading to the Bibioninae, but not within the Bibioninae as currently defined. Including this species of the Bibioninae would mean that the diagnosis of this distinctive subfamily would have to be rewritten, so we choose to erect a new subfamily for it. The species could possibly be close to an ancestor for the Bibioninae, which are known from fossils back to the Upper Cretaceous. A similar, probably congeneric species occurs in the Cretaceous Crato fossil beds of Brazil. We attempt to sum up what we can tell from the fossils about the evolutionary history of the family Bibionidae.

POSTERS

Ambers accurately reflect tree-dwelling arthropods, but not broader forest community

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Amber, the fossilized resin of various kinds of trees, preserves soft-bodied organisms that otherwise would virtually fail to be present in the fossil record. Although these finds have yielded important anatomical and paleoecological data points, amber preservation implies taxonomical biases, as in the other fossil preservation types, and thus most likely fails to accurately record the full composition of arthropod forest paleocommunities, leaving an open question: Is any part of the forest well-represented? To examine this question, we recently analyzed the ensemble of hexapods (mainly insects) and arachnids (mainly spiders) naturally trapped by tree resin from *Hymenaea verrucosa* Gaertner, a resinous leguminous tree in the lowland coastal forest of Madagascar, and compared our findings with assemblages captured by standard entomological traps placed in and close to the same tree species (Solórzano Kraemer et al. 2018). We demonstrated that assemblages in resins accurately reflect the arthropod species living in or near the tree but fail to represent the arthropod community in the forest as a whole. Thus, ambers are a suitable fossil record so long as the research focus is limited to characterizing corresponding ancient resiniferous tree communities. Particularly, some arthropod groups such as Collembola, Lepidoptera, and some Diptera, are underrepresented in resins. However, results from resin assemblages differed slightly from sticky traps, perhaps because chemical compounds in the resins attract or repel specific insect groups. Ground-dwelling or flying arthropods that use the tree-trunk habitat for feeding or reproduction are well-represented in the resin assemblages, implying that fossil inclusions in amber can reveal fundamental information about biology of the past.

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Reference

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TALKS

POSTERS

Where the hell ants roamed: predicting Mesozoic ant biogeography throughout the Cretaceous

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The earliest definitive ants date to the Cretaceous, approximately 100 million years ago (Ma), appearing in two roughly contemporaneous deposits in France and Myanmar. In total, there are approximately 45 species from 8 amber and compression fossil deposits, spanning the Cretaceous both geographically and temporally; this relatively expansive paleontological dataset is valuable for understanding the biogeography, morphology, and diversity of Cretaceous ants. Many early ants were morphologically bizarre, particularly the haidomyrmecines or "hell ants": these ants possessed an array of vertically-aligned trap-jaw mandibles and horn structures unlike anything seen in extant species. Along with these highly specialized hell ants, there are a wide variety of other Mesozoic ants with putatively distinct functional roles and habitat specificities. The fossil deposits known were likely laid down in temperate or tropical forests, but many questions yet remain about the ecology of Cretaceous ants. What were the climatic and vegetative conditions under which Mesozoic ants diversified? How did their distributions shift over time as the climate of the Cretaceous changed? Why did these stem Cretaceous lineages die out, and other lineages later rise to ecological dominance? Ecological niche modeling is a tool that we here employ to understand the biogeography and potential ecological niches of the Cretaceous ants. While ants are often ubiquitous in terrestrial environments, lineages of modern ants are constrained by abiotic factors such as precipitation, temperature, soil types, and vegetation; these conditions may be extrapolated back to the Cretaceous. Using proxy data from paleobotanical specimens and carbon and oxygen isotope ratios, we model the climatic and vegetative conditions across the planet during the Cretaceous at different time slices. Our model illustrates the ecological niche ranges of the Cretaceous ants, by both detailing the likely paleoclimatic conditions at known fossil ant localities, and predicting the global distributions of known extinct lineages. This model also acts as a window into how these conditions changed over time, potentially revealing migrations or local extinctions of the earliest ants, leading up to their final extinction sometime near the end of the Cretaceous.

Relationship of Recent Panorpoidea (Insecta, Mecoptera) in light of a new concept of family Orthophlebiidae

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TALKS

The polyphyletic family "Orthophlebiidae" is considered to be a stem group of the superfamily Panorpoidea, forming a grade leading to the recent clade, consisting of only two living representatives: Panorpidae and relictual Panorpodidae. The reconsideration of the taxonomic boundaries of Orthophlebiidae was necessary to form a basis for a phylogenetic analysis within the superfamily Panorpoidea. Our study was based on diverse, well preserved and abundant fossils of Mecoptera fauna that were found in the Jiulongshan Formation of Middle-Late Jurassic age at Daohugou village, Ningcheng County, Inner Mongolia, China, and which allowed us to detect multiple morphological characters. The crucial step in a clarification of the relationships between the genera within the family was a detailed study of the morphology of the male abdomen based on multiple specimens with their bodies preserved. A new systematic concept of the polyphyletic family Orthophlebiidae and an amended diagnosis of the orthophlebiid genera were thus provided. The study indicated that the abdomen morphology is quite different in representatives of the genus *Protorthophlebia,* which had previously been determined based only on wing venation, and thus erroneously included within Orthophlebiidae. It led to the decision to separate *Protorthophlebia* from Orthophlebiidae and to erect a new family: Protorthophlebidae. Those new taxonomic data enabled us to reconsider mutual relationships within the superfamily Panorpoidea and between the two recent families. It is suggested that Panorpidae and Panorpodidae belong to separate, much older phylogenetic lineages, and lack a direct common ancestor. The results also delimit the direction of the phylogenetic relationships study within the superfamily Panorpoidea, which reflects the evolutionary history of living Mecoptera.

POSTERS

The Fossil History of Mayflies (Ephemeroptera) in Amber

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The fossil record of mayflies in amber is reviewed. From a few records in Cretaceous amber of New Jersey to only recently unearthed, numerous mayfly fossils in Burmese amber, we have by now an excellent overview of mid- Cretaceous mayfly fauna, which can be characterized as a mixture of Mesozoic extinct taxa and early representatives of modern families. In the Paleogene, most modern families are reported from Eocene Baltic amber. Some of these are confined today to the Neotropics or are of amphinotic distribution. One species found in Baltic amber cannot be distinguished from an extant species by morphological comparisons, which raises the question of how long a species can survive. Some mayfly taxa in Baltic amber do not fit into paleoecological reconstructions of an Eocene subtropical environment, and different hypotheses try to explain the occurrence of cold-adapted freshwater insects in the Baltic amber forests. Finally, an overview of the mayflies of Dominican amber is given.

Late Triassic to early Paleogene Fossiliferous Ambers of Australia reveal ancient windows into Southern Pangean and Gondwanan terrestrial worlds

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New amber discoveries from the Late Triassic to early Paleogene of Australia enhance greatly our knowledge of the evolution of terrestrial ecosystems through geologic time in both southern Pangea and Gondwana. Many of these records provide the only known fossil evidence of the earliest occurrence(s) of many taxonomic elements in the modern fauna and flora. Here we report the first Australian amber occurrences from the Triassic (Carnian, ~230 Ma) in Tasmania; an early Late Cretaceous (late Cenomanian–Turonian, ~96-92 Ma) record from the Otway Basin, Victoria; a Late Cretaceous (Santonian–Campanian, ~86–84 Ma) occurrence from the Gippsland Basin, Victoria; and three amber-rich deposits from the early Paleogene of Victoria and Tasmania, (early Paleocene, Danian ~66-62 Ma; early Eocene, early Ypresian ~54-52 Ma; and late middle Eocene, late Lutetian–early Bartonian ~42-40 Ma), the latter two of which contain significant arthropod, plant, fungi, and microorganism inclusions. Diverse arthropod groups comprise hexapods (springtails of the Entomobryomorpha and Symphypleona), insects (Diptera belonging to the families Dolichopodidae and Ceratopogonidae; lepidopteran scales, hymenopterans of both winged and worker ants from the Formicidae (Myrminicinae); hemipterans,

scale insects of the Eriococcidae and possibly Tingidae; Blattodea); arachnids (of order Acariformes (mites) including the families Erythraeidae, Anystidae and one undetermined Oribatida); diverse, fragmentary arthropod material; and probable coprolites. These early to late middle Eocene fossils represent the only recorded pre-Neogene Southern Gondwana animals preserved in amber. Rare bryophytes and mosses (at least four new species) in the families Radulaceae and Racopilaceae are discovered for the first time in the Southern Hemisphere amber record, among diverse plant matter, fungal remains and microorganisms, including palynomorphs, and nematodes. The number of new fossiliferous localities and diverse inclusions of many new and previously unfossilised groups are exciting new developments in Southern Hemisphere amber palaeontology with the sheer volume of amber collected indicating that we have just started to scratch the surface in terms of the spectrum of bioinclusions.

Polyxenida in mid-Cretaceous Burmese amber

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The diplopod subclass Penicillata and its single order Polyxenida, generally known as "bristle" millipedes, are the sister group to all other millipedes. They possess unique morphological characters, such as soft, un-calcified cuticle, specific trichomes on head and trunk, trichobothria on posterior margin of the head, gnathochilarium with a pair of palps, the presence of penes or vulvae near the second coxa and the absence of gonopods. The extant Polyxenida currently comprises 4 families, 31 genera and over 150 species, occurring on all continents except Antarctica. Polyxenids are well adapted by having a subcortical habitat where the majorly feed on algae on tree bark, and they can also be commonly found in litter layers of the soil.

Fossils of the Polyxenida are very rare and only known from amber. A total of 11 fossil species have been formally reported: 6 from Eocene Baltic amber, 3 from Early Cretaceous Lebanese amber (including an unidentified species), 1 from Early Cretaceous French amber, and 1 from mid-Cretaceous Burmese amber.

We recently found numerous polyxenid specimens in Burmese amber, including 2 genera with 3 species that could be assigned within 2 families. *Phryssonotus burmiticus* (Cockerell, 1917), belongs to the extant family Synxenidae and genus *Phryssonotus*. We also found 2 new species which can be confidently placed in the extant family Polyxenidae. Both species can be assigned within the extant genus *Pauropsxenus* based on features of ommatidia, trichome, sensilla and other critical characters. All the 3 polyxenid species from Burmese amber closely resemble their extant counterparts, suggesting an evolutionary stasis of the order from the Cretaceous to the present. Therefore, the Late-Cretaceous mass extinction may not have severely affected the order. The conservational morphology of Polyxenida may be due to its subcortical and leaf litter habitat.

TALKS

POSTERS

Polyxenids use "physical" means to protect themselves from their predators, rather than chemical defense used by other diplopod taxa: the last 2 leg-pairs of synxenids are modified to hairy pads, which are used for short-distance jumping in order to escape from predators; special modified caudal trichomes present in the Polyxenidae and Lophoproctidae can be shed to immobilize predators. Both of these defensive characters are found in our specimens, demonstrating that Cretaceous polyxenids had already developed these defensive systems.

True hoppers and hopperity of the mid-Cretaceous and its importance

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Burmese amber contains the most diverse biota in amber from the Cretaceous. During the last 100 years, Burmese amber has received worldwide scientific interest and more than 480 families of plants, fungi and animals have been reported. Among the immense variety of insects entombed in Burmese amber, the Diptera, Coleoptera, Hymenoptera, and Hemiptera are the most diverse orders. A few striking examples of recent findings of true hoppers – planthoppers (Fulgoromorpha), leafhoppers, treehoppers, froghoppers, cicadas and their relatives (Cicadomorpha) – are given below.

The term “hopperity” was introduced in 2017 by Szwedo, and it can be explained as a play of words – a one-word descriptive term covering taxonomic diversity, morphological disparity, good quality and relatively high quantity of the inclusions of the hoppers among the Burmese amber inclusions.

Fulgoromorpha – families including the extant Cixiidae and Achilidae, as well as the extinct Jubisentidae, Lalacidae, Mimarachnidae, Neazoniidae and Perforissidae – can be found. A preliminary overview of the inclusions deposited in various institutions and available for study revealed maybe ten or more taxa deserving familial status. The most troubling were the inclusions which could be placed in a Cixiidae-like lineage, leading to questions of family monophyly, definition and diagnostic characters, as well as content and classification.

Cicadomorpha representing the Clypeata clade – Tettigarcidae (hairy cicadas), previously known as fossils exclusively from sedimentary deposits – were recently described for the first time as inclusions in amber. The representatives of singing cicadas, the Cicadidae, were described based on nymphal specimens, but these data must be verified. The groups in question are extremely rare among the inclusions, probably due to taphonomic biases of preservation as inclusions, not their scarcity in paleoenvironments.

Sinoalidae – an extinct family related to froghoppers previously recognized from the Middle Jurassic Daohugou Biota and coeval strata of northeastern China, were reported for the first time as inclusions. Another family – Aphrophoridae was also listed, but presence of this family among inclusions needs to be reinvestigated and confirmed.

Cicadellidae (leafhoppers), recently the most speciose and diverse family, are also present as inclusions in Mid-Cretaceous Burmese amber. Representatives of the subfamilies Ledrinae, Signoretiinae and Coelidiinae were already known, but more await formal descriptions. The whole- bodied fossils entombed in amber will give new insight on the morphological characters, diversification of the family, and process of 'leafhopperisation' of these insects.

The extinct bizarre family Minlagerrontidae was recently described, representing the Hylicelloidea, believed to be ancestral to modern superfamilies.

The period documented by Burmese amber biota has been the most crucial for the understanding of the evolution of modern true hoppers, and the hopperity presented by these fossils reflects the rapid diversification and extinction among them.

Late Cretaceous Tilin amber biota from central Myanmar

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Insect faunas are extremely rare near the latest Cretaceous, with a 24-million-year gap spanning from the early Campanian to the Early Eocene. We report a unique amber biota from the Upper Cretaceous (uppermost Campanian ~72.1 Ma) of Tilin, in central Myanmar. The chemical composition of Tilin amber suggests a tree source among conifers, indicating that gymnosperms were still abundant in the latest Campanian equatorial forests. Eight orders and 12 families of insects have been found in Tilin amber so far, making it the most recent known diverse insect assemblage in the Mesozoic. The presence of ants of the extant subfamilies Dolichoderinae and Ponerinae supports that tropical forests were the cradle for the diversification of crown-group ants, and suggests that the turnover from stem groups to crown groups had already begun at ~72.1 Ma. The age, chemical components, and inclusions of Tilin amber are different from those of the mid-Cretaceous Kachin amber in northern Myanmar, showing a biotic change from mid-Cretaceous to Late Cretaceous. Tilin amber biota fills a critical insect faunal gap and provides a rare insight into the latest Campanian forest ecosystem. Following ongoing excavation of Tilin amber, future discovery of arthropods and plants is promising and will provide new insight into the coevolution between early angiosperms and insects during the latest Campanian.

TALKS

POSTERS

Early Cenozoic dipterocarp rainforest in central Tibet revealed by amber fossils

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The paleoenvironmental reconstruction of central Tibet is key to understanding the uplift history of the Tibetan Plateau, which had a profound influence on Cenozoic global climate and biotic change. Here we report an amber outcrop from the lower part of the Dingqing Formation (late Oligocene) in Lunpola of central Tibet, which is the first record of amber from Tibet. We find that Lunpola amber is derived from dipterocarp trees, as determined by gas chromatography-mass spectrometry, and these trees are restricted to and dominant in Asian rainforests today. The ancient amber forest represents the northernmost dipterocarp forest and is consistent with the hypothesis of an 'out-of-India' dispersal of Asian dipterocarps. The Lunpola amber may be redeposited, and thus derived from the lower part of the Niubao Formation (Early–middle Eocene). We suggest that a tropical/subtropical wet forest was present in central Tibet at least before the late Oligocene (probably Early–middle Eocene).

Vertebrate records in Cretaceous Burmese amber

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Burmese amber preserves the most diverse paleobiota among the major deposits of Cretaceous amber, with inclusions that include: fungi, plants (bryophytes, ferns, conifers, and angiosperms), arthropods, gastropods, worms, feathers, lizards, frogs, birds, and non-avian theropods. Most of the amber comes from the Upper Cretaceous (Lower Cenomanian, 98.79±0.6 Ma) of the Hukawng Valley, northern Myanmar, and a small amount of amber comes from Upper Cretaceous (uppermost Campanian ~72.1 Ma) Tilin amber mines of central Myanmar.

So far, vertebrate records of the Hukawng biota include squamates, isolated feathers and skeletal fragments from avian theropods (enantiornithines) and non-avian theropods, and amphibian remains. The Hukawng biota has produced countless specimens which are held in many institutions, and were collected with different biases, making complete statistics nearly impossible. The Dexu Institute of Palaeontology (DIP) in China holds a large collection (about 300 specimens, as of January 2018) of Burmese amber with vertebrate remains. Of these specimens, 65.5% are isolated feathers, 4.1% are attributable to birds (complete and incomplete skeletons), 0.3% are non-avian theropod, 0.7% are snakes, 27% are lizards, and 2.4% are amphibians (frogs and salamanders).

Isolated feathers account for a high percentage of vertebrate inclusions, because molted feathers from birds are abundant and can be easily captured by resin. As both non-avian theropods and avian theropods have asymmetric feathers, it is difficult to distinguish isolated feathers from these groups. However, the growing number of specimens with associated skeletal material is allowing us to refine our understanding of feather characteristics in these groups, and some of the unusual morphotypes that have proven difficult to interpret in compression fossils. Non-avian (coelurosaurian) theropods, and bird records (such as wings, feet or skeletons) in amber are extremely rare. Only enantiornithines have been recorded, and Neornithes are conspicuously absent from the assemblage.

Snakes have also been rare in the assemblage, but highly informative. *Xiaophis myanmarensis,* a unique and very tiny snake fossil, is an articulated postcranial skeleton. The skeletal morphology shows similarities to those of fossil Gondwanan snakes, suggesting a dispersal route of Gondwanan faunas to Laurasia. *Xiaophis* is the first Mesozoic snake to be found in a forested environment, indicating greater ecological diversity among early snakes than previously thought. Skin interpreted as belonging to a much larger snake has also been found in Burmese amber from the Hukawng biota. This specimen preserves a fragment of shed skin with traces of pigmentation patterns.

Lizards are frequently seen in the Hukawng biota, due to their small size and excellent climbing ability. The most common findings are fragments of skin and limbs. The initial studies of lizards from this deposit have revealed substantial diversity. A large number of undescribed specimens will add significantly to this diversity in the future.

Amphibians are closely associated with fresh water environments. *Electrorana limoae* and some other frog specimens found in the Hukawng biota were recently described. *Electrorana* provides the earliest direct evidence of frogs in wet tropical forests from Cretaceous Burmese amber.

Most of the vertebrate groups that have been documented to date are biased toward smaller individuals or life stages, and are represented by fragmentary remains. However, these specimens provide a valuable supplement to the compression fossil record, where the opposite bias is present.

They also allow us to investigate soft tissues in an unprecedented level of detail. Ultimately, collections from this deposit will provide insights that are not available from other sources.

The Chironomidae fauna of early Eocene Cambay amber reveals unusual Tanytarsini (Diptera: Chironomidae)

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TALKS

The Tanytarsini, today a species-rich tribe within the family Chironomidae, is known also from a high diversity in the Eocene. A significant number of representatives have so far been described from various fossil resins originating from that epoch, i.e., from amber of the Baltic region (including the specimens preserved in Rovno amber) (~43–48 Ma), from Fushun amber from China (~50–53 Ma), and now also from early Eocene Indian amber (54 Ma).

Several species of four tanytarsine genera have been found in a rich material obtained from the Tadkeshwar and Vastan lignite mines located in Gujarat state in northwest India.

The recently established genus *Gujaratomyia* Giłka & Zakrzewska, 2018, described on the basis of 3 well-preserved adult males of *Gujaratomyia miripes* Giłka & Zakrzewska, 2018 shows a unique composition of leg characters that have not been observed in other fossil or extant Tanytasini. A frail and simply branched median volsella is a key feature for *Tanytarsus* sp. 1, whereas long, narrow and pointed gonostyli separates *Tanytarsus* sp. 2 from other Eocene Tanytarsus species. *Stempellina* sp. 1 combines characters typical of extant species, but also those of other genera (e.g. anal point spinulae), most likely derived from a close ancestral common group. *Stempellinella* sp. 1 shows another unique feature – an additional, stout thumb-shaped process located on the hypopygial inferior volsella, this structure present only in a few extant species but strongly reduced.

POSTERS

The examined zooinclusions contain 192 specimens of five Chironomidae subfamilies: Chironominae, Orthocladiinae, Tanypodinae, Podonominae and Prodiamesinae.

Except for the Podonominae record, the composition of Cambay amber chironomids most closely resembles a Dominican amber fauna. The presence of genera dwelling in freshwater habitats, both lentic and lotic, along with other dipteran groups recorded in amber pieces from this deposit, have allowed us to sketch a probable composition of locally separated, diverse aquatic and semi-aquatic paleohabitats.

The Fossil Insect Collaborative TCN: digitizing fossil insect collections across the USA

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TALKS

Funded in 2013 by the National Science Foundation ADBC Program, the Fossil Insect Collaborative TCN project aimed to digitize just under 500,000 specimens held in the collections of seven institutions in the United States; two additional institutions were funded and added to the project in subsequent years. For most TCN members, the initial year of the project involved setting up or migrating databases, establishing institutional web-based collections searches, developing digitization workflows, purchasing equipment, and the start of data acquisition and imaging. Digitization and publication of data to iDigBio followed in subsequent years. As of 2019, most institutions have completed their digitization efforts; specimen records, including thousands of images, are available via the iDigBio, GBIF, and iDigPaleo portals, and locally via institutional web searches.

The iDigPaleo education and outreach portal was developed as part of the Fossil Insect Collaborative TCN and allows end-users to explore the fossil insect data in a more image-rich fashion and with little prior knowledge of fossil insect taxonomy; the site utilizes filters, which lowers the bar for data exploration. The site was also designed to host classroom activities for K-12 teachers and students, some of which are already available on the site with more in development. Additionally, iDigPaleo has been expanded beyond fossil insects, with data and landing pages for the Cretaceous World TCN and Florissant Fossil Beds National Monuments. Byproducts of the digitization efforts at the University of Colorado are numerous and include: curation of the David Kohls collection of fossil insect from the Green River Formation; connecting specimens with taxonomic experts, which has led to several publications and new type specimens from our collection; addition of our fossil ants on the Ant Web portal; donation of new fossil insect collections; and training of numerous undergraduate and graduate students in insect systematics, digital imaging, databasing, and digitization workflow development. The project will draw to a close at the end of June 2019, but we anticipate that research based on data produced by the TCN will continue for years to come.

POSTERS

TALKS

POSTERS

Fossils shed light on phylogeny and early divergence of Paederinae rove beetles (Coleoptera: Staphylinidae)

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Paederinae is one of the most diverse subfamilies among rove beetles, comprising more than 220 genera and about 6,300 species worldwide (Newton, unpublished database). For a long time, they genera were grouped into two tribes: Pinophilini and Paederini, and 13 subtribes (two in Pinophilini, 11 in Paederini) [1]. A recent molecular-based phylogeny led to the adjustment of the paederine tribal system that now consists of four tribes: Pinophilini, Cylindroxystini, Lathrobiini and Paederini [2]. However, generic limits and subtribal division within all tribes have never been rigorously assessed. Especially problematic is the main part of the tribe Lathrobiini, consisting of the subtribes Medonina, Astenina, Stilicina, Stilicopsina, Echiasterina and Scopaeina with more than 3,000 described species. This lineage represents the major diversity of the tribe and dominates the (sub)tropical areas of the world. Lack of taxonomic revisions, absence of keys for identification, unclear generic limits and presumably a large number of undescribed species in the tropics make paederines a 'taxonomic nightmare' hampering biogeographic, ecological or evolutionary studies. More efforts to explore the phylogeny and improve the classification of Paederinae are needed at all taxonomic levels. Obviously, fossils are a major source of phylogenetic information for the subfamily, but poorly developed systematics is an impediment for their study. So far, the described fossil record of Paederinae includes 32 species from 8 genera ranging from Early Cretaceous to Miocene, but there are many more awaiting description.

My research shows that applying a phylogenetic approach can be very helpful in finding the taxonomic position and assessing phylogenetic relationships of Paederinae extinct taxa. Together with my collaborators, we performed a total evidence analysis to place two species from the Cretaceous Burmese amber, which required constructing the first morphological matrix for the subfamily and collecting additional molecular data. This work revealed the position of the fossil taxa within the abovementioned mega-diverse cluster of subtribes, which were thought to be recent radiations. Our research showed that they are actually much older and have pushed back the origin of the entire subfamily, providing new insights into the evolution and classification of the entire subfamily.

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POSTERS

Biogeographic history of the Persian Ironwood highlighted by a new plant-insect interaction discovered in Germany (-3 Ma)

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An instance of insect damage on a leaf reflects millions of years of evolution. Today, plants and insects contribute to more than 70% of the biodiversity on the Earth. Their interactions are crucial for the environmental structure of continental ecosystems. Nevertheless, until the late Twentieth Century there was no formal ichnotaxonomy system to designate traces of insect feeding on fossil leaves. Focusing studies on these plant-insect interactions in the fossil record is a very recent discipline; only ten years ago Labandeira et al. (2007) compiled all the known plant-insect interactions in the fossil record, but new ones can always be found. Precisely, during investigations in the Lagerstätte of Willershausen (3 Ma, Germany), a new insect feeding trace has been identified, named DT297. This damage looks like a long-bent concatenation of circular perforations less than 5mm in diameter. There is also another "version" of this damage, twice as large, probably due to a different larval stage of the insect. In addition to this new release, there is another specificity for DT297, because now, despite more than 10,000 fossil leaves which have been analyzed, the DT297 is exclusively found on one plant species: *Parrotia persica* C.A.Mey (Hamamelidaceae). Moreover, this damage (i.e. DT297) has also been found on the present leaves of P. persica, which is today endemic to the Hyrcanian Forest (northern Iran). It has already been hypothesized that the present Hyrcanian forest was the best analogue of the European paleoforests from the late Cenozoic. The presence of DT297 on both fossil and current P. *persica* significantly supports this hypothesis. In conclusion, this discovery also raises several new questions and perspectives about the potential of plant-insect interactions as a good indicator in (paleo)ecology. These herbivory traces could provide insight into the biogeographical history of a plant species, its evolution, and the evolution of its environment. In future studies of fossil leaf collections, the identification of plant-insect interactions should become an integral part of the analyses.

TALKS

POSTERS

Cretaceous Odonata from the Koonwarra lagerstätte, Victoria, Australia

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The Lower Cretaceous Koonwarra Fossil Bed is one of the most important fossil sites in Australia, discovered in the 1960s by workers straightening a section of the South Gippsland Highway in southeastern Victoria, Australia. This *lagerstätte,* renowned for both the diversity and preservation of its fossils, is mainly known for its fossil fish, but is also abundant in invertebrates, including a wide range of insects.

The fossil odonatans, like other invertebrate fossils from this site, were first described in detail in 1986 by Peter Jell and Peter Duncan. Since then, several authors have questioned the classification of many of these specimens, and discovered discrepancies in some of the original specimen descriptions. Further, paleontology has progressed significantly since the 1980s, with technological advances enabling fine details on the specimens to be more easily visualised, and higher quality photos to be obtained. For this project, I reviewed all the fossil Odonata currently known from Koonwarra, including a new specimen found in March 2018. The specimens were re-imaged, re-described and reclassified wherever possible. In total, fourteen odonatan naiads and the partial wing of *Peraphlebia tetrastichia* Jell & Duncan, 1986 were re-described. All dragonfly naiads were removed from the species *Peraphlebia tetrastichia* and placed into open nomenclature, with three separate morphologies identified. *Niwratia elongata* Jell & Duncan, 1986 was re-described as an anisopteran naiad and grouped with another of the anisopteran naiads due to morphological similarities, with both specimens potentially placed into the family Libellulidae. The other specimens could not be assigned to families due to the unclear preservation of diagnostic features. Of the zygopteran naiads from Koonwarra, two were described individually as each displayed unique features separating them from the other fossils, with the remaining seven zygopterans likely representing a single species. None of the zygopteran naiads could be associated with any specific family; however, the material was compared to families such as the Synlestidae, Coenagrionidae and Perilestidae. The partial wing of *Peraphlebia tetrastichia* was removed from the family Mesophlebiidae, and left in open nomenclature, due to the missing basal portion of the wing. Using modern odonatans as an analogue, the palaeoenvironmental conditions represented at the Koonwarra site were confirmed to have an aquatic nature, either a lake or river. The small nature of the odonatan specimens suggests that the Koonwarra site would have been closer to a temperate climate than a polar climate and year-round frosts could not have been possible — this idea agrees well with some previous interpretations of this site.

Fossil Achilidae (Hemiptera, Fulgoromorpha) more questions than answers?

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Achilidae Stål, 1866 is a planthopper family that is not very large and speciose, but has complex taxonomic subdivisions. It groups over 160 genera (6.6% of the Fulgoromorpha) and about 550 species (3.8% of the Fulgoromorpha). These taxa include extant and a few extinct representatives, and are distributed worldwide, but are more speciose in Northern Hemisphere's tropical and subtropical zones. All Achilidae are obligatory phytophagous, opophagous terrestrial insects; they mainly feed on host plants belonging to the following orders: Arecales, Asparagales, Asterales, Boraginales, Cornales, Cupressales, Ericales, Fabales, Fagales, Hamamelidales, Lamiales, Laurales, Malpighiales, Malvales, Myrtales, Pinales, Poales, Rosales, Sapindales, Vitales. The oldest fossil is known from the Lower Cretaceous (Aptian), and the highest number of extinct taxa are known from Eocene Baltic amber. Recently, a number of Achilidae and relatives were identified among Burmese amber inclusions.

Taxonomic history of Achilidae is complex, dependent on opinions and definitions of the groups in which it has been placed and which are placed within the family. The first fossils which need to be placed in the family were described in 1856 by Germar and Berendt, but were given as representing the genus *Cixius* of the family Cixiidae. During the following 135 years, another fossil from Baltic amber was named (Cockerell 1910), and also one from sediments (Cockerell 1922), then one more Baltic amber inclusion was described by Usinger (1939). Those fossils were treated in a family revision by Fennah (1950). The 1990's brought several discoveries and changes: the first fossil of the oldest Achilidae from the Aptian Crato Formation (*Acixiites* Hamilton, 1990); the extinct tribe Ptychoptilini from Baltic amber (Emeljanov 1990); and new opinions on content, subdivisions and definition of the family (Emeljanov 1991, 1992, Emeljanov & Flecher 1994). The 21st Century brought more fossils: some from the extinct tribe Waghildini (Szwedo 2006); plus more genera and species (Lefebvre et al. 2007, Emeljanov

& Shcherbakov 2009). The content and concepts of the family also changed – the status and placement of Achilixiinae, Bebaiotinae and Ptychoptilini as part of Achilidae were challenged. Discoveries of fossils in mid-Cretaceous amber from Myanmar brought more questions and challenges. Several fossils which could be placed in recent tribal classification were found, but changed the view on times and sequence of separation of tribes. Other fossils cannot be placed in known tribes and could represent families related to Achilidae. Cenozoic fossil resins – the Oise, Baltic and Dominican ambers – brought new taxa and new challenges for revisionary and taxonomic studies. Achilidae belongs to one of the oldest lineages among Fulgoroidea, and the diversification and dispersion of the group, its relationships and evolutionary scenarios, all seem to be pieces of a circuitous puzzle that needs to be assembled.

A third known representative of subfamily Centrocnemidinae (Hemiptera: Heteroptera: Reduviidae) from Baltic Amber

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Only two representatives of Centrocnemidinae from Baltic Amber have been described so far: *Redubitus centrocnemarius* Putshkov & Popov, 1993 and *Redubinotus liedtkei* Popov & Putshkov, 1998. The modern fauna of the subfamily contains only 4 genera and about 30 described species, distributed exclusively in South and Southeast Asia. During our study, an inclusion of a new adult specimen of a centrocneminous bug, which could not be placed in any of the known genera, was discovered in Baltic Amber deposited in the Collection of Department of Zoology, University of Silesia (DZUS). *Yuriella popovi* gen. nov., sp. nov. is the second known individual of Centrocnemidinae from Baltic Amber in the imaginal stage. It can be easily distinguished from *Redubinotus liedtkei* Popov & Putshkov, 1998 by its different head shape (postocular part is very narrow, eyes are large and placed anteriorly), the morphological characters of pronotum (anterior pronotal lobe is distinctly narrower than posterior pronotal lobe; posterior pronotal lobe with regular margins, distinctly formed 4 pairs of large denticles, and three) and scutellum (three large denticles visble on antero-lateral angles and on the apex of scutellum; apical denticle oriented horizontally). There are also visible differences in wing venation as well as the presence of denticles on the hind femur. This new genus and species will be described in honour of our late colleague Professor Yuri Alexandrovich Popov.

Early Cretaceous Spanish amber reveals an important ancient "hot-spot" of biodiversity in an insular context

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TALKS

Although modern studies on the Early Cretaceous amber from Spain began in the mid-1990s, they substantially intensified when the Spanish government started to fund them in 2005 and until the present day (AEI/FEDER, EU Grant CGL2017-84419). Since its beginnings, the Spanish amber project has had a multidisciplinary approach, addressing topics such as the geology of the deposits and their age, the geochemistry and taphonomy of the amber, and the paleobiological data provided by amber inclusions. As the Spanish amber deposits are protected by law and all the samples were obtained in paleontological excavations carried out by specialists, all the material is housed in museums and other public institutions, which has allowed a rigorous investigation of the material unearthed so far.

During the Cretaceous, the Iberian plate was isolated as a large island on the western margin of the Tethys and partly bathed by the Proto-Atlantic. Eastern Iberian amber deposits are associated with freshwater swamps, whereas those in the north developed in deltaic environments with a more or less marine influence. The initial dating of the amber outcrops providing bioinclusions as Aptian–Albian was subsequently adjusted, based on pollen and regional geology, to upper Albian. At least two different families of conifers produced the resin that originated the Spanish amber: Cheirolepidiaceae and an indeterminate conifer in the northwestern deposits (El Soplao); Araucariaceae close to the genus *Agathis* in the northern deposits (Peñacerrada), and possibly also Cheirolepidiaceae in the eastern deposits (San Just). A number of hexapod orders have been found: Archaeognatha, Blattodea (including Isoptera), Coleoptera, Collembola, Diptera, Hemiptera, Hymenoptera, Lepidoptera, Mantodea, Mecoptera, Neuropterida, Orthoptera,

POSTERS

TALKS

Psocoptera, Thysanoptera, and Trichoptera. In terms of abundance, dipterans and hymenopterans are predominant. Other arthropod groups have also been discovered, such as arachnids (Araneae, Acari, and Pseudoscorpiones), as well as crustaceans (Tanaidacea, and Isopoda). A significant collection of feathers has also been recovered. Recently, Spanish amber has provided remarkable data on plant-insect interactions, namely those representing the first known and oldest direct evidences of pollination relationships between gymnosperms and different insect groups, i.e., thrips, long-proboscid flies and beetles. Other noteworthy subjects of paleobiological research have been the study of edaphic and aquatic arthropods and the evolution of camouflage in neuropterans. Lastly, actuotaphonomic studies carried out in Mexico and Madagascar have shed light on how representative the arthropod associations trapped in resin are when compared to the ecosystem composition. Differences in resin production and trapping capacity between angiosperms (*Hymenaea* ssp.) and gymnosperms (*Agathis* spp.) is now a work in progress.

POSTERS

New fossil insects from the Lower Barremian dysodiles of Lebanon

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Dysodile shales are finely laminated rocks rich in organic matter and in fossils. Despite cropping out in different localities across Lebanon and belonging to different lacustrine geological formations (Barremian and Albian), dysodiles have scarcely been mentioned in the literature, leaving their depositional environment widely unknown. We focus herein on the Lower Barremian dysodiles, found in the fluvio-deltaic sandy facies of the "Grès du Liban" unit which include as well the amber deposits in Lebanon and the Levantine area. The studied deposits correspond to small lakes of limited extension (of a few km2). Their presence near to volcanic altered rocks, or associated with volcanic ash, suggests a possible relation between the volcanism and their deposition and/or preservation. Within their layers, Dysodile outcrops hide a huge diversity of macrofossils (ichtyofauna, chelonians, gastropods, plant debris and insects) and microfossils (ostracods, spores and pollen grains) that will provide us with an insight on Lower Barremian paleodiversity. We present herein a preliminary reconstruction of the depositional environment based on the fossil assemblages, geochemical (Rock-Eval) and optical (palynofacies and thin sections) analyses. This study sheds light on the paleontological importance of the dysodile shales, which could be hiding a 'missing link' that will improve our understanding of the evolution of modern fauna. To date, 40 fossil insects have been found preserved in dysodiles, belonging to Ephemeroptera, Diptera and Hymenoptera. The dysodiles (together with the Lebanese amber outcrops occurring in the same geological unit) will significantly add to the diverse new cradle of fossil insects from the Lower Barremian.

TALKS

Traumatic sex for the first Mesozoic damsel bug in Burmese amber? (Hemiptera, Nabidae)

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The Nabidae (sensu Schuh and Štys, 1991) is a relatively small family of cimicomorphan bugs, with 31 genera and 386 extant species (after Coscarón et al., 2015). There is very little data on the fossil Nabidae sensu stricto despite several doubtful assignations. The oldest relatively accurate Nabidae sensu stricto are Middle Eocene. Here we describe the first Mesozoic representative of this family from mid-Cretaceous Burmese amber. Using microtomography X, fluorescence microscopy as well as classical microscopy, we created a 3D reconstruction to analyze the anatomical and morphological structures of its genitalia. We discuss the evolution of traumatic sex (traumatic insemination) within this family and the other cimicomorphan lineages.

Coscarón, S., Braman, S.K. and Cornelis, M. 2015. Chapter 11: damsel bugs (Nabidae). pp. 287-305. In: Panizzi, A.R. and Grazia, J. (eds). True bugs (Heteroptera) of the Neotropics. Entomology in Focus, Springer, 2: i-xxii + 1-901.

POSTERS

Dipteran Pupae of the Eocene Kishenehn Formation

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Diptera constitute the majority of the fossil fauna of the Middle Eocene Coal Creek Member of the Kishenehn Formation in northwestern Montana, U.S.A. Nearly thirty different families of the order Diptera are known from the formation and, as a result of the unusually high quality of preservation, the fauna is rich in relatively little-known clades. Examples include *Aenigmatias* (Phoridae), *Synneuron* (Canthyloscelidae), *Macrocera* (Mycetophilidae) and *Hoplocyrtoma* (Hybotidae). Over the course of several years of field work many hundreds of specimens of immature stages of aquatic diptera have been collected, the vast majority of which are pupae. Most numerous are the pupae of Chaoboridae > Chironomidae > Ceratopogonidae > unknown. Preserved morphological details, figured herein, include patterns of spines and shagreen of abdominal tergites, anal lobe setation, anal combs and spurs and structural details of the frontal apodemes in Chironomidae, the reticulated meshwork of the respiratory horns of Chaoboridae and the poration patterns of the respiratory organs of Ceratopgonidae. Preliminary studies have identified multiple morphotypes in each of these several different families. Future analyses may allow for generic assignments of several of the specimens.

TALKS

POSTERS

Psocopterans from the Mid-Miocene Dominican Amber

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Insects belonging to order Psocoptera Shipley, 1904 (*sensu* traditional classification), commonly known as booklice and barklice, are particularly rare as inclusions in Dominican amber. To date, only three psocopterans, assigned to three different families have been described from this amber material: *Belaphopsocus dominicus* Grimaldi and Engel, 2006 (Liposcelididae); *Myopsocus arthuri* Nel *et al.*, 2006 (Myopsocidae) and *Echmepteryx* (*Loxopholia*) *dominicanus* Hakim *et al.*, 2018 (Lepidopsocidae).

The approximate age of Dominican amber has been subject to controversies during the last half-century, with several ages being attributed by different researchers. The latest was Iturralde-Vinent (2001), who studied the geology and stratigraphy of the various amberiferous deposits in Greater Antilles and assigned a mid-Miocene age (circa 16 myr) to the Dominican amber. From the latter, we studied, described and illustrated the new species *Echmepteryx (Loxopholia) dominicanus* Hakim *et al.*, 2018. This taxa, which was attributed to subfamily Lepidopsocinae Enderlein, 1903, is the only fossil record of the subfamily. It is characterized by a distinctive head coloration pattern, the presence of scales and setae on various body parts and 40 antennal segments. Lepidopsocids, rather well diversified in recent fauna, remain very scarce as fossils. This new record is the first lepidopsocid species discovered from Dominican amber, thus the second oldest known lepidopsocid (the oldest occurring in the Eocene amber of Oise, France). Moreover, we described the female of species *Myopsocus arthuri* Nel *et al.,* 2006, initially based on a male individual from the same amber. We also gave the specific diagnosis (missing in the original description), and we added some extra characters to the specific description (such as the distinctive head and thorax coloration pattern or the presence of a pulvillus on the claws) and compared this extinct species to the recent taxa found in the American continent. *M. arthuri* constitutes the only known fossil record for the family Myopsocidae.

The discovery of this new material is important for understanding the evolution of psocopteran families, especially Myopsocidae and Lepidopsocidae. Furthermore, the study of Psocoptera (and insects in general) in Dominican amber contributes to our knowledge of the paleobiodiversity of the local amber producing forest.

TALKS

POSTERS

Psallopinae (Hemiptera: Heteroptera, Miridae) in Baltic amber

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The modern species belonging to Psallopinae are usually characterized (with some exceptions) by 2-segmented tarsi, the claws with a subapical tooth, a single cell on the membrane, very big eyes occupying almost the entire head nearly overlapping the gula, and very low-set antennae. All recent species generally have small bodies (usually 2-3 mm). Psallopinae, today mostly inhabiting tropical and intertropical regions, lead a cryptic life and their chorology is poorly known. Most of them were collected in light traps.

Up until now, representatives of five genera of Psallopinae have been described from Baltic and Dominican amber: *Isometopsallops* Herczek & Popov, 1992; *Epigonomiris* Herczek & Popov 1998; *Cylapopsallops* Popov & Herczek 2006; *Epigonopsallops* Herczek & Popov, 2009 (Baltic amber); and *Psallops* Usinger 1946. Some described fossil species (e.g. *Cylapopsallops kerzhneri* Popov & Herczek 2006, *Isometopsallops schuhi* Herczek & Popov, 1992, *Epigonomiris skalskii* Herczek & Popov 1998) differ from the recent forms by having a bigger body size (ca. 5 mm) and 3-segmented tarsi. However, all of them have a subapical tooth on claws, and do not have ocelli. A mosaic of the remaining morphological characters suggests a close relationship between Psallopinae and Isometopinae. A maximal reduction of ocelli in some fossil Isometopinae may suggest that Psallopinae is a taxonomic unit within Isometopinae (Herczek & Popov, 1992). The discovery of fossil psallopine bugs in Late Eocene Baltic and Ukrainian amber, especially the oldest representative *Isometopsallus prokopi* Vernoux, Garrouste & Nel, 2010 from Lowermost Eocene French amber, as well as a representative in Lower-Middle Miocene Dominican amber, indicates that the appearance and spreading of this peculiar mirid group happened not later than during the early Cenozoic.

Amber (succinite) in Ukraine

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The territory of Ukraine covers the southeastern part of the Baltic-Dnieper amber province, the latter stretching from the shores of the Baltic Sea to the Black Sea and the Sea of Azov. This province is the main source and supplier of succinate (Baltic) amber to world markets. The source area of this fossil resin was formed by erosion of paleopeats and lignite layers of Late Eocene age. Subsequent accumulation of resins (proto-amber) took place in the marine Eocene-Oligocene basin, which connected the tropical Tethys with the North Atlantic Ocean. The amber-succinite placer that formed in this basin was subsequently partially eroded and re-deposited again by river waters, glaciers and other geological denudation agents. The well-preserved remnants of Eocene fauna and flora can be found in these amber specimens. Other varieties of fossil resins are common in the Ukrainian shield (retinites) and in the Carpathian region (rumanite, deliatinite, etc.).

At present, amber-succinite is intensively mined in the Pripyat amber-bearing basin (north-western and northern parts of the Ukrainian Shield), and episodically in the Dnieper basin (the middle and lower part). The predicted resources of amber/succinite in the Pripyat basin are ca. 100 thousand tons. Most of the deposits and amber occurrences are related to the shallow-marine coastal and delta facies of the Lower Oligocene and, to a lesser extent, to the Upper Oligocene and continental formations of the Neogene and Pleistocene.

Shallow location of productive horizons, forests, swamps, lack of roads, and remoteness from large settlements contributed to the development of illegal mining, which led to significant environmental degradation. The state enterprise for amber extraction and processing is "Ukrburshtin," which, along with a private company "Sonyachne remeslo," satisfy the demands of the Ukrainian market.

First terrestrial arthropod records from the Miocene amber of Sumatra

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During the past ten years, many new fossil resin outcrops of different ages have been found on nearly all continents, ranging in age from the Late Carboniferous to the Holocene. Our knowledge on fossil terrestrial arthropods has greatly increased, thanks to the study of the inclusions in some of these resins, especially for the Cretaceous of Europe and Asia. Nevertheless, terrestrial fossil arthropods are clearly lacking in some areas crucial for the understanding of the Mesozoic and Cenozoic paleobiogeography. It is especially the case for the Indonesia. Even if these islands are hot spot for extant biodiversity, nearly no fossil arthropod is described from there. Cenozoic amber from Borneo, Java, and Sumatra has been recently found and analyzed, probably produced by trees of the family Dipterocarpaceae (Naglik et al. 2018). Nevertheless, no arthropod inclusion has been recorded in these resins. One of the authors has recently acquired a series of 200 arthropod inclusions from a trader from a Miocene amber outcrop in the western portion of the Central Sumatra Basin. The amber is red and rather opaque, due to numerous small bubbles and impurities. The insects are also frequently deformed, probably because the amber was partly heated by volcanic activity that occurred in the area during the Miocene (Kosmoswska-Ceranowicz et al. 2017). Nevertheless, the fauna is rather diverse with representatives of Coleoptera, Hymenoptera, Isoptera, Diptera, Dermaptera (three nymphs), Hemiptera (one Cicadellidae and one Veliidae), Lepidoptera, Neuroptera (Coniopterygidae), Orthoptera (a cricket), Odonata (wing fragment of a Zygoptera), and Thysanoptera. The most frequent fossils belong to one species of Curculionidae: Platypodinae. The Formicidae (Formicinae, Ponerinae and Myrmicinae, workers and alate adults) and the Termitidae (alate adults) are the second and third families in term of abundance. They are more numerous than the Diptera, which is relatively strange, since flies are generally very frequent in fossil resins.

Diptera are represented by Mycetophilidae, Bibionidae, Chironomidae, Limoniidae, Scatopsidae, Phoridae, and few other Brachycera. One Staphylinidae: Pselaphinae and one Carabidae: Scaritinae have also been identified. Six Arachnida have also been found. This entomofauna suggests a forest under a warm and humid climate, especially for the abundance of Platypodinae and termites living in wood. A specimen of an apterous aquatic bug suggests the presence of freshwater very close to the resin-producing trees. Future studies can provide precious information on the Miocene fauna of the area and its relationships with extant fauna.

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Report on Pseudoscorpions in New Jersey Amber

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The Summary list of Fossil Spiders and their Relatives presented by Dunlop, Penney, and Jekel (2019) makes no mention of pseudoscorpions in New Jersey amber. However, pseudoscorpions do exist in New Jersey amber, but have yet to be studied (Harms & Dunlop, 2017; Grimaldi et al., 2002). Therefore, I will make the first identification and official report pseudoscorpions preserved in the Turonian New Jersey amber. The specimens of interest were provided by the American Museum of Natural History and a private donor, currently in KU holdings. The specimens have embedded for conservation and have been imaged and illustrated. Computed tomography is used to visualize the specimen free from debris and imperfections in the amber and highlight diagnostic characters. The identification of these specimens will be added to the New Jersey amber faunal assemblage and provide additional fossil context for Pseudoscorpiones in the Mesozoic era. Currently, there are only four pseudoscorpions identified from the Mesozoic era, but by the end of this study there will be six therefore improving our knowledge of pseudoscorpions (Dunlop et al., 2019; Harvey, 2013).

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Jurassic phreatoicid isopods from Victoria Land, Antarctica

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The isopod suborder Phreatoicidea has the earliest known fossils in the Isopoda. Extant phreatoicideans live in epigean or hypogean fresh waters of Australia, New Zealand, South Africa, and India, indicating that their biogeographical distribution originated from ancient Gondwana. Fossil records of phreatoicidean isopods include two palaeophreatoicids, *Hesslerella* from the Carboniferous of the U.S. and *Palaeophreatoicus* from the Permian of Russia, and two amphisopid species of the genus *Protamphisopus* from the Middle Triassic of China and Australia. In Triassic-Jurassic paleogeography, today's phreatoicidean-harboring regions were surrounding Antarctica, implying an overlooked presence of this isopod group in Antarctica. In the course of a joint United States and British Antarctic expedition 1971/1972, multiple specimens of phreatoicidean isopod fossils were collected from lacustrine deposits intercalated in the late Early Jurassic Kirkpatrick basalt at Carapace Nunatak of southern Victoria Land, Antarctica. An additional specimen—collected during the German GANOVEX IX expedition during 2005/2006 from a similar sedimentary interbed within Kirkpatrick basalt at Gair Mesa, northern Victoria Land—may indicate a wider distribution of this Jurassic phreatoicid in Antarctica. Detailed morphological features of the phreatoicidean fossils from Antarctica are being assessed, which will be used for phylogenetic analysis. Preliminary observations show that the Jurassic phreatoicideans from Antarctica have head and pereiopod features readily distinct from those of the Triassic *Protamphisopus.* The Jurassic specimens from Antarctica may thus provide more information about the morphology of Mesozoic phreatoicideans, and possibly cast light on the obscure biogeographic evolution of the group.

New morphology details of megasecopteran family Bardohymenidae from Early Permian of Tshekarda (Russia)

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Megasecoptera is one of the orders of Palaeodictyopterida, which occurred during the Late Carboniferous and Permian. The group shares with other palaeodictyopterids specialized piercing and sucking mouthparts in the form of a rostrum, which allowed it to stab plant tissues and suck juices. Representatives of Palaeodictyopterida varied greatly in size, wing venation complexity, and even in number of wing pairs (Paleodictyoptera are known for additional winglets on the prothorax, in contrast to some members of Permothemistida with hindwings reduced).

Most of the Megasecoptera families designated through the first half of the 20th century were frequently based on isolated wings only. The first described families (e.g. Mischopteridae, Sphecopteridae) come from the Late Carboniferous (Gzhelian; 303.4–298.9 Ma) of Commentry in France; however many of these specimens are heavily compressed, and the body structures are not finely preserved. Later, some adult specimens attributed to Protohymenidae, as well as nymphs of Mischopteridae, were described from Late Carboniferous (Moscovian; 315.2–307.0 Ma) of Mazon Creek sideritic nodules in USA. Another exceptionally preserved entomofauna comes from the Late Carboniferous (Bashkirian; 318.1–314.6 Ma) of Xiaheyan in northern China, which includes a large series of specimens of *Brodioptera sinensis* (Brodiopteridae), revealing new morphology details. This species demonstrated male and female external copulatory organs and allowed us to study intraspecific variability of wing venation. Rich material of megasecopterans has also been documented from an Early Permian locality – Tshekarda in the Russian Federation. Presently it includes members of four families: Bardohymenidae, Protohymenidae, Scytohymenidae, and Vorkutiidae, commonly found with well-preserved body structures.

The family Bardohymenidae comprises several assigned genera, but only genus *Sylvohymen* provides details of body morphology apart from the wings. Our study revealed a new specimen of male *Sylvohymen sibiricus* Kukalová-Peck, 1972, supplementing the previous female specimen. The male genitalia of S. *sibiricus* are comparable to other megasecopterans, consisting of segmented gonopods (forceps) and paired penial lobes. Another significant character of some megasecopterans is an apical cell in the wing venation, which seems to be variable in shape across the family Bardohymenidae, but rather stable among other families (e.g. Protohymenidae, Scytohymenidae).

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A new inchworm moth specimen from Miocene Dominican amber (Lepidoptera: Geometridae)

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Records of Lepidoptera are rare in amber due to taphonomic factors (Solórzano Kraemer *et al.*, 2018), and consist mostly of adult moths. In Mesozoic amber, only adult moths have been found. From Miocene Dominican amber, several extant moth families have been cited or figured, but to date only two specimens of the family Tortricidae have been studied in detail, with the description of two extinct genera (see review by Heikkilä *et al.*, 2018). We report an inchworm male moth virtually complete (except for some portions of the antennae) and finely preserved in a clear piece of Dominican amber (wingspan ca. 30 mm as preserved). Fore and hindwings appear only partially overlapped, and all body characters are visible externally in dorsal and ventral views, including the valvae of the genitalia. The scale pattern on the wing membrane is preserved, whereas the wing color pattern is not. The intact preservation of the wings, except for minor damage in the posterodistal margin of the left hindwing, reveals that the moth became trapped in resin shortly after emerging, to be rapidly and entirely covered by subsequent resin flows. This new specimen belongs to the family Geometridae, most likely being an Ennominae which appears to be close to the genus *Ennomos*. Grimaldi & Engel (2005) figured another adult specimen and a caterpillar in Dominican amber; their moth, which also belongs to Ennominae, differs from our specimen in some wing venation features. Because of the poor fossil record of lepidopterans, the description of the available well-preserved specimens is of considerable interest. We report for the first time an inchworm moth which could help improve future estimations of the rate of molecular change using molecular clocks.

Acknowledgements

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TALKS

POSTERS

Springtails on eusocial insects: an ancient hitchhiking tale

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Phoretic behaviour – cases of organisms attaching onto other organisms for the implied purpose of dispersal – is among the least understood categories of interspecific associations. Consequently, instances of phoresy are often described as associations between small organisms and mobile larger ones that show no clear benefit other than transport. This holds especially true when trying to interpret the fossil record. Apart from a few Paleozoic reports, fossil springtails (Hexapoda, Entognatha, Collembola) are primarily reported from Cretaceous and Cenozoic amber deposits, in which they have occasionally been documented as attached to other invertebrates. These fossil associations correspond to three cases of Symphypleona attached by the antennae to different parts of larger arthropods' bodies (e.g. legs; Poinar 2010, Penney 2012, Grünemaier 2016). Remarkably, such instances of putatively phoretic behaviour have no known modern counterpart, which is very rare for repeated fossil behaviours.

Here, we document a new case of collembolan phoresy preserved in Dominican amber. A single amber specimen reveals associations with both termites and ants, displaying not just a few, but a striking 26 springtail individuals attached to or in close proximity with social insects. This new Symphypleona species exhibits attachments on elements of host anatomy that have not been previously reported, as well as a specific antennal anatomy that includes rarely preserved fossil organs reflecting specific courtship behaviours. By (1) comparing the relative position of Collembola and potential hosts, (2) documenting modes of attachment, and (3) observing ratios in host/springtail antennal anatomies, we infer a likely attachment strategy for dispersal. In addition, by pointing out (1) hidden evidence of modern springtails associated with other invertebrates, such as ants and termites, (2) new cases of fossil syninclusions of Symphypleona and termites, and (3) the drastic increase of eusocial insects' abundance in Cenozoic deposits (ants and termites together comprise up to a third of the total insect biomass in Miocene amber), we suggest that this behaviour, which is probably still performed by extant lineages, may be a reflection of co-evolution between Symphypleona and social insects over time.

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Palynological studies of the Upper Triassic amber bearing levels of the Dolomites: Indications for conifer evolution

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The famous Upper Triassic amber of the Southern Alps comes from the Heiligkreuz Formation in the eastern Dolomites and the Rio del Lago Formation in the Julian Alps (e.g., Seyfullah et al., 2018). It was collected in levels also yielding dispersed cuticles/leaves, plant remains and wood fragments. This fossil resin became famous for its amazing inclusions preserved inside the single (small) amber droplets, permitting us to discover a microworld normally not preserved in the fossil record (Schmidt et al., 2006). In addition, the amber-bearing levels of the Dolomites (northern Italy) represent the only known source of early Mesozoic amber-preserved arthropods (Schmidt et al., 2012, Sidorchuk et al, 2015).

Through an integrated study of palynomorphs and macroremains, the fossil assemblage can be also used as a base for considerations on the evolutionary history of modern conifer families. At least three different conifer shoot types have been identified in the flora, attributed respectively to different conifer groups, i.e. Voltziales, Cheirolepidiaceae and ?Majonicaceae (Roghi et al., 2006). The palynological analyses of the amber-bearing horizons have yielded a wide range of pollen grains assignable to conifers such as bisaccates (*Triadispora* group, Voltziales) and taeniate bisaccates (Majonicaceae?), monosaccates (Voltziales, Majonicaceae?) and Circumpolles (Cheirolepidiaceae), indicating that several conifer families coexisted during this period in the Dolomites. However, these conifer groups are not all specific to the sediments they were found in, since Majonicaceae is a Permian conifer family, and the Cheirolepidiaceae is typical for the Jurassic and Cretaceous. The Late Triassic conifers in Europe generally belong solely to the Voltziales. Morever, the taeniate bisaccate pollen grains are not rare elements, but are in fact represented by several genera (*Lueckisporites, Lunatisporites, Infernopollenites*) that are abundant in the palynoflora. These findings re-open the discussion on the origination, disappearances and radiations of several major conifer groups in the Triassic.

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Growth of nymphal wing pads in Palaeodictyoptera and other insect groups

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The phylogenetic position of the superorder Palaeodictyopterida is uncertain, but current views support its placement among basal lineages of Pterygota, either with palaeopterous orders (Odonatoptera and Panephemeroptera) or as a sister group to Neoptera. While adults are rather frequent, the nymphal stages of Palaeodictyopterida are scarcely found in Paleozoic deposits. They are commonly preserved only as isolated wing pads or as complete body exuviae. The nymphal wing pads of Palaeodictyoptera were medially articulated; however, it is still unknown whether they were at least partially movable. In contrast, the nymphal wing pads of extant species of Palaeoptera and Neoptera are fully fused with the notum, and are immovable. The original function of palaeodictyopteran wing pads also remains unclear. In the past, a wide range of hypotheses for their function have been proposed, for instance for thermoregulation, gliding or even active flight. Moreover, some members of Palaeodictyoptera and Geroptera (Odonatoptera) possessed developed prothoracic lobes, so-called winglets.

We reexamined very rare material in detail, consisting of a series of palaeodictyopteran nymphal wing pads attributed to *Tchirkovaea guttata* (Tchirkovaeidae) from the Early Permian of Tschekarda in Russia. This material allowed us to study developing wing pads during various nymphal stages, along with other body structures. We compared our results with the growth of developing wings in selected groups of extant insects. Such comparisons can provide more information on wing growth during postembryonic development in one of the oldest groups of Pterygota.

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The swarming of Collembola through time

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The ability of resin to encapsulate small portions of the paleoecosystem in a relatively fast and quasi-unaltered way, and to preserve them for millions of years, gives amber paleobiological significance, and explains why amber inclusions are especially valuable for studying how organisms interacted in the past. Here we present extraordinary amber assemblages of inclusions that provide evidence of some ethologies associated with social or pre-social aggregations in springtails (Hexapoda: Collembola). Such behaviors, while critical for the success of species, are frequently impossible to determine for fossil species. The earliest evidence of aggregating behavior in Collembola was documented in an entomobryomorhan species, *Proisotoma communis*, preserved in Late Albian Peñacerrada I (Spain) amber (Sánchez-García et al., 2018). The discovery of fossil evidence for swarming in *P. communis* demonstrated considerable ethological stasis of some behaviors that are common in extant Collembola. Now, direct evidence of aggregating behavior in Collembola is provided by newly found associations of entomobryomorphan springtails preserved in fossil and Recent resins, produced by both gymnosperms and angiosperms, from different locations and ages: in Cenomanian (99 Ma) Burmese amber; and in Miocene (20 Ma) Dominican amber; as well as in Recent *Hymenaea verrucosa* resin from Madagascar. This considerably expands the fossil evidence of this behavior. It is remarkable that all of the springtail assemblages are found in litter amber/resin pieces, and also preserve different elements and organisms typical of the forest floor. The diverse samples composed of litter-inhabiting fauna were entombed by resin flows directly onto the ground from different parts of the source trees. The superb preservation of the samples has allowed us to study not only their content, but their taphonomical characteristics. These specimens constitute surprising examples of swarming on the forest floors and shed new light on the edaphic habitats of these deep-time forests.

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Seeing the invisible: using synchrotron microtomography on an unusual fossil Eocene cockroach (Blattodea: Ectobiidae: Blattellinae) from Oise (France)

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Microtomography has allowed us to observe in three dimensions the morphology of a new species of Eocene cockroach preserved in a cracked amber fragment from the Oise lowermost Eocene amber (France). The current classification of the Blattodea, even at a familial rank, is primarily based on genitalia characters, but these structures are generally not preserved in fossils, rendering any assumptions on their affinities very doubtful. In our case, the scanned specimen, a male, has its genitalia partially devaginated. This allows very precise observation and, consequently, an assignment to the modern family Ectobiidae, more precisely to the subfamily Blattellinae, with a high level of confidence. To our knowledge, this is the first reliable fossil of this subfamily. It is of major interest in understanding the evolution of modern roaches, as well as studying the phylogeny and dating the Blattellinae. Moreover, this taxonomic identification highlights a case of convergent evolution regarding the exceptionally elongated morphology of this fossil.

TALKS

New Miocene genus and first record of Hybotinae (Diptera, Empidoidea, Hybotidae) from Dominican amber

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We present the discovery of a new fossil genus and species of the family Hybotidae in Dominican amber. The new genus belongs to the subfamily Hybotinae and shares some characters with the genera *Syneches and Stenoproctus;* however, the differences, principally in the wing venation (shortened cell cua, horizontal m-cu crossvein), support the recognition of a new genus. We will dedicate the new species to the family Caridad to thank their effort and support for the investigation of Dominican amber.

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POSTERS

Museum of Amber Inclusions, University of Gdańsk: 20 years of science and education

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The Museum of Amber Inclusions (MAIUG) was established in 1998 by the University of Gdańsk Senate. The founder of the Museum, Professor Ryszard Szadziewski, was then the head of the Department of Invertebrate Zoology. The MAIUG is now an integral part of the Laboratory of Evolutionary Entomology and the Department of Invertebrate Zoology and Parasitology, Faculty of Biology, University of Gdańsk, Poland. The university's collection of amber inclusions is extensive, preserving numerous amber pieces, and particularly amber samples with biological inclusions for taxonomic research. In addition, it is a fundamental tool for understanding the palaeobiodiversity, palaeobiology and palaeoecology of the ancient amber forest.

The Museum was an outgrowth of the collaboration between scientists and the amber-workers of Gdańsk, who were focused on a return to the pre-World War II tradition of collection and research on the natural history of amber. The museum's collections and activities began humbly with an initial number of 63 amber pieces with inclusions, 50 kg of raw Baltic amber, and a small dark room with a simple polishing machine and steel cabinet housed in the former Department of Invertebrate Zoology in Gdynia in 1998. The collection was erected for scientific purposes, but with a growing number of specimens and growing interest in amber inclusions, the educational and exhibition aspects of the museum were developed, as well as meetings and courses devoted to amber and its inclusions. In 2013, the Department and Museum moved to a new building of the Faculty of Biology. In this building, the Amber Laboratory was established, with new equipment for preparation of amber samples and for documenting inclusions, which has significantly facilitated new research. The Museum now contains a 150m2 exhibition area with a life-size diorama of the Baltic amber forest, and a diverse selection of Baltic amber inclusions on display. The MAI UG collection presently includes nearly 6000 amber pieces with over 15000 described zooinclusions, including over 60 Type specimens. Eocene Baltic amber is the main component of the collection. However, other fossil resins with and without bioinclusions are also housed there. A fossil database of the bioinclusions is available, with numerous data recorded concerning each amber piece itself, organisms entombed within (inclusions and syninclusions), its provenance, collectors and investigators, as well as treatment. All these data are unique and provide a reliable base for understanding the palaeobiodiversity, palaeobiology and palaeoecology of the ancient amber forest, and also enable researchers to carry out taxonomic and taphonomic studies concerning amber and its inclusions.

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"Rolling" Stoneflies (Plecoptera) from Mid-Cretaceous Burmese Amber

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This contribution reports seven new species of fossil stoneflies from Cretaceous Burmese amber, all of which are dedicated to present and past members of the Rolling Stones. Two species, each in a new genus, are placed in a new family within the stemline of Arctoperlaria: Systellognatha. They exhibit a setose arolium and short first tarsomere, which are evaluated here as potential apomorphic characters of Systellognatha. Tarsal euplantulae and numerous crossveins in the costal field are plesiomorphies shared with remaining Systellognatha. The plesiomorphic proximal origin of RP excludes the position of the new family in the crown group Systellognatha, and RA reaching the wing apex might be an autapomorphic character of the new family. Also discussed is the first Cretaceous larval specimen of Perlidae: Acroneuriinae, along with another four new species that are placed within the recently described Acroneuriinae genus *Largusoperla* Chen et al., 2018.

Reference

Sroka P, Staniczek AH, Kondratieff BC. 2018. 'Rolling' stoneflies (Insecta: Plecoptera) from mid-Cretaceous Burmese amber. *PeerJ* 6:e5354 https://doi.org/10.7717/peerj.5354

Unique characteristics of amber aphid ((Hemiptera, Aphidomorpha) fauna from the mid-Cretaceous Burmese amber of northern Myanmar

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The Cretaceous and particularly mid-Late Cretaceous constitute a crucial period in aphid phylogeny. It was during this period that most recent groups of insects originated. Only several Cretaceous aphids have been described based on rock impressions. Our understanding of Late Cretaceous fauna relies primarily on genera and species found as amber inclusions.

Aphids are reported from several Mesozoic fossil resins, including Lebanese, Spanish and New Jersey ambers, which all originated in a warm climatic zone. Although each of these amber sites has yielded thousands of inclusions, aphids in these sites have been scarce (a total of 5 species described from 5 inclusions). In contrast, aphids are quite common in mid-Cretaceous Burmese amber.

The majority of described aphid taxa from this amber belong to family Burmitaphididae; 3 species represent Isolitaphidae; whereas Parvaverrucosidae and Szelegiewicziidae contain one species each. The Burmese amber aphid fauna is highly endemic: representatives of Isolitaphidae, and Parvaverrucosidae have only been reported from that location. Interestingly, the Burmitaphididae family, which is the richest overall in fossil species (6) and specimens (16), contains only a single specimen from Spanish amber: *Alavesiaphis margaritae* Peñalver and Wegierek, 2008. The uniqueness of fauna from Burmese amber is also manifest by the fact that the frequency of males present as inclusions in this amber is very high; this is not typical of aphids elsewhere.

Accordingly, the question arises: what abiotic and biotic conditions were responsible for forming such a unique aphid fauna from Burmese amber?

A new, nearly complete fossil meganisopteran (Insecta: Odonatoptera) of Westphalian C/D age from the Piesberg quarry near Osnabrück, Germany

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The large quarry within the Piesberg N Osnabrück, Lower Saxony, Germany, is mainly known for its rich and exceptionally preserved fossil flora. But it is also a very important Late Carboniferous (Pennsylvanian: Westphalian C/D) locality for fossil insects. More than 200 specimens, mainly preserved as isolated wings, have been collected during the last three decades. Most of them were found by two collectors over the last 10 years. They are still housed in private collections and are not yet described. They altogether comprise more than 20 new individuals of Odonatoptera: Meganisoptera. Their description is in preparation by the present authors. Thus the Piesberg is one of the most important Fossil-Lagerstätten of Late Carboniferous Odonatoptera in Europe. Till now only *Erasipterella piesbergensis* BRAUCKMANN, 1983 and *Piesbergtupus hielscheri* ZESSIN, 2006 had been named. One of the new specimens is a nearly complete animal which is documented herewith for the first time. Some additional photographs show how the Piesberg quarry developed during the last few years.

References

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