8. Bernstein-Workshop am 16. März 2017
im Rahmen der Deutschen Entomologentagung 2017
in Freising

Chair: Wilfried Wichard

Kurzfassungen

Keynote

The rise of the ants revealed in amber

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Ants are a conspicuous element of modern terrestrial ecosystems, are distributed virtually worldwide, and have an expansive range of behaviors and interactions with other organisms. The vast majority of over 13,000 extant species belongs in the "big four" subfamilies Dolichoderinae, Formicinae, Myrmicinae, and Ponerinae. However, despite the presence of ants on Earth for over 100 million years, their rise to dominance has been relatively slow, and they appear to have been only moderately abundant and diverse for about the first half of their history. This is well documented in the fossil record and a focus is made here on fossils entombed in amber, as they harbor the finest preservation and offer a tantalizing glimpse of ant diversity at various points in the past. Ants never surpass 1.5% of the total insects in Cretaceous amber deposits, where they mostly comprise stem-group ants that did not survive beyond the Cretaceous-Cenozoic boundary. In Early Eocene amber, prevalence increases up to 10%, and all identifiable ants are assignable to crown lineages. Also, dominance of the "big four" subfamilies is already largely consistent into the Eocene, during which a burst of diversification evidently occurred. In Miocene amber, ant prevalence reaches 25–36% and all specimens are assignable to extant genera. A temporal midpoint in the history of ants is thus reached in the Early Eocene, ~ 50 million years ago, with a distinct shift observed in their abundance and diversity. Finally, all modern lineages had appeared by the middle Miocene, ~ 15 Ma, and major changes since then mostly comprise their geographical diversification.

Keynote

Hemiptera stories preserved in fossil resins

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Hemiptera is one of Big Five insect orders together with Coleoptera, Lepidoptera, Hymenoptera and Diptera – the most speciose and diversified insects. Their evolutionary history could be traced back to the Carboniferous and the inclusions in fossil resins are known since early Cretaceous. The oldest inclusions of the Hemiptera comes from the Lebanese amber, aged Barremian – representatives of various groups – scale insects, whiteflies, aphids, moss bugs, true bugs and planthoppers are reported. Surprisingly, no leafhoppers were found yet among these inclusions. A few only are known so far from Cretaceous ambers of France and Spain. Rich and sometimes very peculiar fossils, still weakly elaborated, comes from Burmese amber, aged earliest Cenomanian. Few more Hemiptera were reported from the other Upper Cretaceous ambers: Taimyr, New Jersey and Canadian. The knowledge about Hemiptera from the ambers of Eocene is biased towards Baltic amber (incl. Bitterfeld and Rovno), but the others – ambers of Oise, Cambay, Fushun, brought important findings of the various Hemiptera groups. Baltic amber inclusions of the Hemiptera are the best known, with numerous aphids, scale insects, planthoppers, leafhoppers and true bugs, less numerous psyllids and whiteflies. The knowledge of these fossils is still far from complete, more and more outstanding and important inclusions must be thoroughly elaborated. Miocene findings of various Hemiptera groups in Dominican and Mexican ambers are sometimes spectacular; still little is known about inclusions of hemipterans in ambers from Zhangpu, Indonesia, Cape York, New Zealand, but preliminary reports are very promising. Amber inclusions preserved not only data about taxic diversity, morphological disparity, palaeodistributions of the Hemiptera, but also important data about habitats they live and behaviors they presented.

The oldest record of the basal Chironomidae subfamily – Buchonomyiinae

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Non-biting midges or chironomids (Diptera, Chironomidae) are the most widespread freshwater insects in the world. Chironomids are common inhabitants of most aquatic, semiaquatic and some terrestrial habitats; they often dominate benthic communities in terms of both abundance and species richness. Chironomidae have a long and well-documented geological history, with earliest records from upper Triassic. Among the 11 modern subfamilies of chironomids, Buchonomyiinae are the most primitive and considered to be a sister group to the rest of the chironomids. Subfamily is monotypic with a single genus *Buchonomyia*, including 3 modern species from Europe, South-East Asia and Central America, and a single fossil species *B*. *succinea* Seredszus and Wichard, 2002, from the Baltic amber. Elusive nature of the larvae and pupae, who are developing as parasites or commensal of caddisflies larvae is making records of the even recent Buchonomyiinae extremely rare. According to the latest dated phylogeny of the Chironomidae (Cranston et al., 2012), Buchonomyiinae have branched from the rest of the Chironomidae in the lower-to mid-Jurassic. Here we are presenting the oldest record of the genus *Buchonomyia* from the upper Cretaceous Burmese amber. New species is presented by the single, well-preserved male, closely reminiscent of modern species, however easily distinguishable by the bootshaped Inferior volsella, and presence of 2 strong setae on the dorsal lobe of the gonostylus.

More than just adults – arthropod ontogeny preserved in amber

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The exquisite preservation of arthropods in amber allows a comparably easy recognition of morphological details. Based on this, a vast amount of species has been recognised from amber deposits. The species diversity again has been used to reconstruct the interactions of past ecological communities. Yet, there are significant shortcomings of such an approach. In modern ecosystems the majority of living arthropod individuals will never reach adulthood, but most likely becoming a "passive" part of the food web, i.e. become eaten long before they mature. Therefore, a more holistic reconstruction of food webs of the past demands for not only including adults but also non-adults. Reports of non-adults, and even more so detailed descriptions are comparably rare, most likely due to the fact that it is often not possible to recognise new species based on such specimens. Yet, amber is in fact very rich in non-adult arthropods and has the potential, quite different from most other types of preservation, to also provide a detailed reconstruction of the life history of organisms. We present here different examples of immature arthropods preserved in amber, from very early stages (hatchlings) to ultimate immature stages (e.g. pupae) and briefly discuss the impact of such findings.

Almost amber: insects in chert

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Amber is a fascinating type of fossil preservation. Insect specimens embedded in amber provide a view onto million years old morphologies in mostly complete arrangement, in three dimensions and often in colour. Therefore, insect fossils in amber have greatly contributed to the reconstruction of the evolutionary history of insects. Yet, amber has an important shortcoming: its young age. Already specimens from the Cretaceous are considered as 'old'. Even older amber has not yet yielded insect fossils. Therefore, amber has so far been uninformative for the very early evolution of insects during the late Palaeozoic. Another preservation type partly sharing some characteristics with amber is chert. Chert is partly transparent, providing access to entire uncompressed specimens in three dimensions. The famous Rhynie chert is about 400 million years old and with this provides a window into the very early evolution of insects. Three insect species have been described from this deposit. We present new details for two of these species: the springtail *Rhyniella precursor* and the putative flying insect *Rhyniognatha hirsti*. We also discuss possible additional insect remains. Based on these results, we re-evaluate the supposed insect diversity 400 million years ago.

Inklusen aus Kopal fehlinterpretiert als Baltische Inklusen – ein aktuelles Problem?

C. Hoffeins, AK Bernstein, Hamburg, Deutschland

Auf dem internationalen Bernsteinmarkt angebotener Kopal aus Kolumbien kann nach mehrfachem Härten in Autoklaven optisch nicht von autoklaviertem Baltischen Bernstein unterschieden werden. Bei fehlender, verloren gegangener oder wissentlich falscher Kennzeichnung von autoklaviertem Kopal kann es bei der Beurteilung von Inklusen zu Fehlinterpretationen kommen, insbesondere bei mangelnder Erfahrung im Arbeiten mit Fossilien.
Einige bekannte Fälle aus der Literatur:
1. Klebs (1910) und Hennig (1966) korrigierten zahlreiche von Giebel 1862 beschriebene Taxa als rezent-fossile Einschlüsse aus Indischem Kopal.
2. Die von Stuckenberg 1975 benannten Bernsteindipteren *Haematopota pinicola* und *Phlebotomus succini* müssen der Afrotropischen Fauna und Kopal zugerechnet werden.
3. Townsend (1921) beschrieb *Palaeotachina smithii* und *Electrotachina smithii* (Diptera: Tachinidae) basierend auf Abbildungen in Zaddach (1868) aus dem Bestand des Museum of Natural History London, später als rezente Arten aus Ostafrikanischem Kopal revidiert.

Hennig, W. (1966): Einige Bemerkungen über die Typen der von Giebel 1862 angeblich aus dem Bernstein beschriebenen Insektenarten.– Stuttg. Beiträge zur Naturkunde, Nr. 162: 1–7.

Multi-methodical documentation of arthropods in amber – squeezing out the last bits of information

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Fossil arthropods enclosed in amber are often preserved in nearly life-like conditions and are therefore an important source for the investigation of morphological, evolutionary and ecological aspects of the now extinct animals. Indeed, the documentation of amber inclusions is often challenging, due to limitations based on reflexions, concavities and convexities of the surface, fissures,

disturbing structures such as gases, liquids, or other objects. In most cases museum specimens cannot be prepared, which could avoid at least some these problems, because of the risk to damage these unique fossils.
We present here different non-destructive techniques to reduce these limitations and to extract the maximum information of the fossils, using a combination of white-light-based (macro- and microphotography), fluorescencebased and X-ray-based methods (µCT). Subsequently, we discuss advantages and disadvantages of the different documentation methods.
For a state-of-the-art micro- and macrophotographic documentation of specimens, we aim at establishing a low-cost and transportable setup, which is particularly useful for investigating specimens on-site in museum collections. We also present different freely accessible software as alternative for often cost-intensive and inaccessible computer programs. Not every documentation method is applicable for every specimen, but a proper combination of different methods allows to extract comprehensive information of the fossil organism.

Taphonomy of Phoridae in Mexican amber

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The Phoridae is one of the most common groups within the Diptera as amber inclusions,
and is a cosmopolitan and species-rich taxon, thus the best taxon to study amber taphonomy.
We can regard sticky tree resin, the precursor to amber, as a type of biotic “trap” that records the flora, fauna, and debris that are accidently stuck and entrapped. Why are Phoridae abundant in amber? Why are so many taxa associated with tree trunks, thereby increasing their chance of becoming accidently entombed as inclusions? Or were, the Phoridae very abundant in the amber forest? Using tree trunk sticky traps as an amber analogue, we can study the taphonomy of recent tree trunk associated faunas and compare this to amber faunas. We compared Phoridae collected with different traps on the modern forest trees *Hymenaea courbaril* in Mexico and *H*. *verrucosa* in Madagascar, with fossil fauna from *H*. *mexicana* (Miocene of Mexico). The present work aims to review

key questions about taphonomic biases and filters of the fossilization processes based on Diptera taxa in amber.

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Advances in psychodid taxonomy and phylogeny – a plea for collaboration of biologists and geologists

R. Wagner, Schlitz, Deutschland

Over the past twenty years taxonomy in general has made progress because new genetic tools have become available that provide a much more detailed insight in taxonomy and phylogeny of the extant fauna. However, not only this progress made it necessary to rehandle the remains of the extinct fauna that are best represented by the preserved inclusions found in the different ambers from all over the planet. What we need more than ever is an approach of people working on the extant fauna [biologists] and those working on extinct faunas [geologists] – collaboration. Further, basic taxonomic procedures must be followed: knowledge of type-specimen and species, use of morphological nomenclature, nomenclatorial rules and so on. Without this collaboration we will keep two fields of science apart that in fact are one. Until ten years ago the Dipteran family Psychodidae was classified into four subfamilies based on the knowledge of the end of the last century. With more material available and a critical view on the feature sets that distinguish groups two more subfamilies were described: one was identified from Burmese Amber, and a second from extant Neotropical material. The Datziinae from Burmese amber were not found in other resins but species of the second subfamily were represented in Baltic and Burmese Amber.

Familie Nevrorthidae (Neuroptera) im kreidezeitlichen Burma Bernstein

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Die Familie Nevrorthidae ist eine kleine Familie der Ordnung Neuroptera und kommt weltweit mit 19 Arten vor, die sich gattungsspezifisch auf vier subtropische Regionen der Welt verteilen. Im eozänen Baltischen Bernstein ist die Familie Nevrorthidae ebenfalls mit neun fossilen Arten in weiteren fünf Gattungen vertreten. Der Kurzvortrag berichtet von Larven und adulten Nevrorthiden im Burma Bernstein. Dieser frühe Nachweis aus der Kreidezeit ist ein weiterer, interessanter Baustein für den Stammbaum und die Verbreitungsgeschichte der Familie Nevrorthidae.

Wichard, W. (2016): Overview and descriptions of Nevrorthidae in Baltic amber (Insecta, Neuroptera) - Palaeodiversity 9(1):95-111. 2016, doi: http://dx.doi.org/10.18476/pale.v9.a7

Wichard, W. (2017): Family Nevrorthidae (Insecta, Neuroptera) in Mid-Cretaceous Burmese amber. - Palaeodiversity 10(1):1-5. 2017
doi: http://dx.doi.org/10.18476/pale.v10.a1

Report on the establishment of a new order of insects from Burmese amber, Insecta, Amphiesmenoptera

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Based on a total of 13 inclusions from Burmese amber the new insect order Tarachoptera was established. The previously described family Tarachocelidae from Burmese amber and then placed in Amphiesmenoptera incertae sedis is assigned to this new order. The family contains two genera, *Tarachocelis* and *Kinitocelis*. The latter genus differs from *Tarachocelis* by the absence of androconial scales on the male wings and the loss of Cu2 in the forewings. Both males and females were described. The species can be distinguished by traits in the wing venation. The new order Tarachoptera is placed in the superorder Amphiesnenoptera based on the presence of seven amphiesmenopteran apomorphies and nine tarachopteran apomorphies.
Apomorphic characters of Trichoptera and Lepidoptera could not be disclosed which suggests an independent origin and evolution from an amphiesmenopteran ancestor which was not the ancestor of the Trichoptera-Lepidoptera. The species of Tarachoptera are tiny insects with wing span of 2.3–4.5 mm but highly specialised

according to their aberrant morphology. Aspects of the presumed life-history of the adults were deduced from some of the derived morphological traits that could be interpreted as adaptions to a highly structured micro-environment.

Mey, W., Wichard, W. Müller, P. & Wang, B. (2017): The blueprint of the Amphiesmenoptera – Tarachoptera, a new order of insects from Burmese amber (Insecta, Amphiesmenoptera). – Fossil Record 20, 129–145, 2017, doi:10.5194/fr-20-129-2017

Tarachoptera: *Kinitocelis hennigi*

Tarachoptera: *Kinitocelis divisinotata*