25TH ANNIVERSARY OF
MUSEUM OF AMBER INCLUSIONS
UNIVERSITY OF GDAŃSK

Fossil Record in Resins and Sediments

BOOK OF ABSTRACTS

UNIVERSITY OF GDAŃSK
23-26 MAY, 2023

FossilRRS Conference

Fossil Record in Resins and Sediments

25th Anniversary
of Museum of Amber Inclusions
University of Gdańsk

BOOK OF ABSTRACTS

University of Gdańsk, Faculty of Biology
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WELCOME

The Museum of Amber Inclusions University of Gdańsk is pleased to invite you to celebrate its 25th anniversary and attend the conference *Fossil Record in Resins and Sediments*, which will be held in Gdańsk, Poland, from 23rd-26th May 2023.

Twenty-five years ago, the natural history collection of amber and inclusions, started from modest beginnings – scientific collection of the Diptera inclusions of Professor Ryszard Szadziewski. What revolutionised the collection was the donation of 50 kg of raw Baltic amber, which completely changed the view on amber, its inclusions and its amber taphocoenosis. The uniqueness of the scientific collection of the Museum of Amber Inclusions is in its positioning within the structures of the University. We are not a collection of specimens, musealia that cannot be touched, but a collection where amber is the basis of scientific discovery and research. Twenty-five years ago, we were at the point when interest in inclusions was developing, and the amber market was growing, and we were present at the Amberif Fair, among the amber workers and collectors, at the centre of the amber (and inclusions) fever. The scientific backbone of the Museum is its collection, research facilities and friends among scientists. The flesh is a collaboration with amber workers, collectors and enthusiasts of amber and inclusions. The blood is the circulation of information, data, ideas, and opinions.

New technologies allow us to look more and more closely into worlds hidden millions of years ago in the solidifying drops of resins. It is the 21st century and we are discovering new pages written in the books of amber, its inclusions and its deposits, but also in the stone books of palaeontology. We will not be able to answer more and more questions on our own – cooperation, exchange of information and experience of geologists, palaeontologists and biologists is needed.

The Conference, which is being held at the University of Gdańsk and supported by the Ministry of Education and Science, will offer an outstanding scientific programme thanks to the participants. It is an opportunity to share the current state of knowledge, new working hypotheses, to debate new findings and new tools, to discuss and find new interpretations of existing data and opinions.

It is with great pleasure that we invite all of you in the spring of 2023 to this Conference, we encourage scientific openness, warm discussions, collaboration, and a shared reading of palaeobiology in fossil resins and sediments. We trust that your stay in Gdańsk – the World Capital of Amber and Museum of Amber Inclusions will be a memorable opportunity for both professional and personal satisfaction.

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palaeobiological conference

23-26 May 2023
Gdańsk, Poland

ABSTRACTS

THE 'CAMBRIAN EXPLOSION'

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Keywords: taphonomy, phosphatisation, Konservat-Lagerstätten, Ediacaran, Precambrian

It is widely believed that the appearance of skeletal fossils at the beginning of Cambrian marks the real evolutionary diversification of the animal world. The preceding 'Garden of Ediacara' is interpreted as inhabited by organisms of no affinity to the present-day phyla. Such interpretation of palaeontological evidence neglects its preservational (taphonomic) aspects. One may rather ask whether the 'Cambrian explosion' truly corresponds to a sudden 'evolutionary radiation' of the animal world or is rather a taphonomic artefact. The extraordinarily well-preserved Ediacaran fossils from the White Sea show the earlier hypothesized connection with the microbial mat but also contribution of iron sulphides to fast lithification of fluidised liquid sediment[1]. Early diagenetic cementation was the main mechanism enabling reproduction of the dorsal surface of the Ediacaran soft-bodied organisms in the sole of an overlying rock bed. The depth of such imprints depends on the resistance of particular organs to collapse under the sediment load at various stages of their decay. Also impressions of the ventral side left by animals resting on the microbial mat may be preserved this way. Series of such imprints frequently terminate with an imprint of a cadaver of the trace-maker[2]. Probably the animal was killed by a toxic agent connected with the microbial mat. Notably, similar spiral traces of activity with a cadaver at their end are known from the Jurassic of Solnhofen, where the associated bivalve *Solemya* indicates hydrogen sulphide as the killing factor. The only indigenous organisms of such environment in the Ediacaran were feather-like petalonameans, rooted with their basal discs in the mat and bearing elevated fronds of a radial or biradial symmetry[3]. Their reliance on chemoautotrophic symbionts seems likely. Apparently, there were also Ediacaran animals inhabiting environments not covered with microbial mats but their fossil record is extremely limited. Traces of locomotory activity of those animals are restricted to minute shallow tracks left by animals living on the sediment surface. They were not able to penetrate the microbial mat. This became possible near the Ediacaran–Cambrian transition[4]. There is a gradation of traces of burrowing activity ranging from horizontal galleries in soft sand, with a fissure left by a proboscis extended to the surface, to a zigzag series of cylindrical chambers[5]. Most, if not all, of those traces of hydraulic penetration were probably produced by relatives of priapulid worms. At the same time, numerous lineages of animals living above the sediment surface developed protective mineral skeleton. Apparently, the diversification of predators in the earliest Cambrian forced other animals to invest energy either in digging or in a protective armour. The most characteristic earliest Cambrian fossil assemblages represent calcareous fossils with secondary phosphatic envelopes. Their sudden appearance is a preservational artefact. A high organic productivity, low sedimentation rate, and shallow bioturbation controlled their distribution. Although less and less abundant, such 'small shelly fossils' continued to occur throughout the whole Early Palaeozoic[6], until the evolutionary diversification of burrowers extinguished such environments. Impregnation with calcium phosphate of even internal organs was a mechanism of fossilisation of macroscopic remains of animals. This was common especially in the Cambrian[7], but similar fossil localities of younger geological age are known, which show that the abundance of such fossils depends mostly on taphonomic factors and not necessarily reflects an explosive increase of taxonomic diversity.

References

1. Dzik J. 2003: Anatomical information content in the Ediacaran fossils and their possible zoological affinities. Integr. Compar. Biol. 43, 114–126; doi:10.1093/icb/43.1.114
2. Ivantsov Yu., Zakrevskaya M. 2023: Body plan of *Dickinsonia*, the oldest mobile animals. Earth Environ. Sci. Trans. R. Soc. Edinb., 1–14; doi:10.1017/S175569102300004X
3. Dzik J., Martyshyn A. 2017: Hydraulic sediment penetration and seasonal growth of petalonamean basal discs from the Vendian of Ukraine. Precambrian Res. 302, 140–149; doi:10.1016/j.precamres.2017.09.024
4. Seilacher A. 1999: Biomat-related lifestyles in the Precambrian. Palaios, 14, 86–93. doi:10.2307/3515363
5. Dzik J. 2005: Behavioral and anatomical unity of the earliest burrowing animals and the cause of the 'Cambrian explosion'. Paleobiology, 31, 507–525; doi:10.1666/0094-8373(2005)031[0503:BAAUOT]2.0.CO;2
6. Dzik J. 1994: Evolution of 'small shelly fossils' assemblages of the early Paleozoic. Acta Palaeont. Polonica 39, 247–313.
7. Cong C.-Y., Hou X.-G., Aldridge R.J., Purnell M.A., Li Y.-Z. 2015. New data on the palaeobiology of the enigmatic, yunnanozoans from the Chengjiang biota, Lower Cambrian. Palaeontology, 58, 45–70; doi:10.1111/pala.12117

FOSSIL RESINS OF THE WORLD, WORLDS OF FOSSIL RESINS

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Keywords: fossil resin, taphonomy, palaeobiology, palaeoenvironments reconstruction, evolutionary process

Natural resins (fossil or modern) are caustobioliths, belonging to the liptobiolites group. Fossil resins are plant secondary metabolites, plant secretions, products of the defence mechanisms of both coniferous and angiosperm trees. These exudates have hardened over time and can be found in coals, fossilized wood, or other sedimentary rocks. Fossil resins, chemically speaking, being water-insoluble complex mixtures of organic compounds such as terpenes, terpenoids and their derivatives, and/or phenolic secondary compounds, liquid and sticky at the beginning, solidify by polymerization. Among the many types of fossil resins, the most noteworthy, both biologically and geologically, are the various types of amber. The secretion of the resin and its hardening occurred under atmospheric conditions, under the environmental conditions of the deposit, and within the deposits. The preservation of resins as fossils depends on how quickly they were buried and isolated from oxygen, sunlight and biological conditions, along with other factors that cause them to biodegrade. Over millions of years, fossilized resins have undergone diagenetic and catagenetic processes. Despite chemical changes, fossil resins also retain chemical traces of the source plants and environments in which they were originally secreted. Fossilized, resinous substances are found in sedimentary rocks from the late Devonian to the Cenozoic[1]. Occurring in various locations around the World, fossil resins, which can be physically and chemically classified as amber[2] are incorporated in geological strata spanning in age from the Carboniferous to the Cenozoic[1,3]. Over the past 25 years of research, fossilized resins, generally thought to be rare across the fossil record and mostly occurring in small quantities, have proven to be a worldwide rather than a local phenomenon.

Deposits in which fossil resins are preserved occur all over the World, and many varieties are recognized; the fossil resins recognized are amber are also not rare; the most interesting are those that contain inclusions. The inclusion is any remain entrapped in amber during its fossilization and diagenesis[1,4]. This term is often narrowed down to numerous, often delicate organic remains entombed in fossil resin. These are usually three-dimensionally preserved, with surface and structural details retained, and most of them are at least roughly conserved in vital aspect and before significant decomposition. Even the tiniest inclusion can play a role in drawing a picture of past environments. Knowledge and understanding of the deposits, fossilized resins and their inclusions, the combination of these provides a unique insight into the ecosystems of the past and is key to predicting the consequences of ongoing biotic crisis.

Several ‘amber bursts’ were identified in the fossil record[2], the first fossil resin that can be classified physico-chemically as amber (Class Ic) is from the Carboniferous of Illinois. However, no inclusions have yet been identified in this resin. The first amber with inclusions is from the early Late Triassic (Carnian, 237-228.4 Mya), a period probably less than 1 million years old and coinciding with the ‘Carnian Pluvial Episode’, i.e. a global and rapid climate change[5] resulting in rapid floristic changes[6]. The second 'burst' in fossil resins and ambers preservation has occurred during the Cretaceous. It comprises the oldest deposits so far with a large amount of inclusions – Barremian Lebanese amber[7], the inclusions-rich resins from Albian–Cenomanian deposits of France[8], Spain[9] and northern Myanmar[10]. These fossilized resins cover a significant portion of the Cretaceous Terrestrial Revolution[11]. Late Cretaceous resins are also notable and inclusiferous, e.g. Raritan amber from New Jersey[12] and Canadian amber[13], ambers from Taimyr[14], central Myanmar[15] or France[16]. Paleogene deposits have yielded the first fossil resins originating from angiosperm trees and containing inclusions – amber of Oise in France[17], and Cambay in India[18]. However, majority of known Paleogene fossil resins with inclusions are derived from gymnosperm trees. This 'burst' is best exemplified by fossil resins collectively known as 'Baltic amber'[19], but with numerous other resins reported[20]. The last 'burst' in fossil resins is documented by Miocene deposits, the most famous are resins from Dominican Republic[21] and Mexico[22], originating from angiosperms, but new finds are emerging, e.g. in China[23], Vietnam[24], Ethiopia[25] or in New Zealand[26].

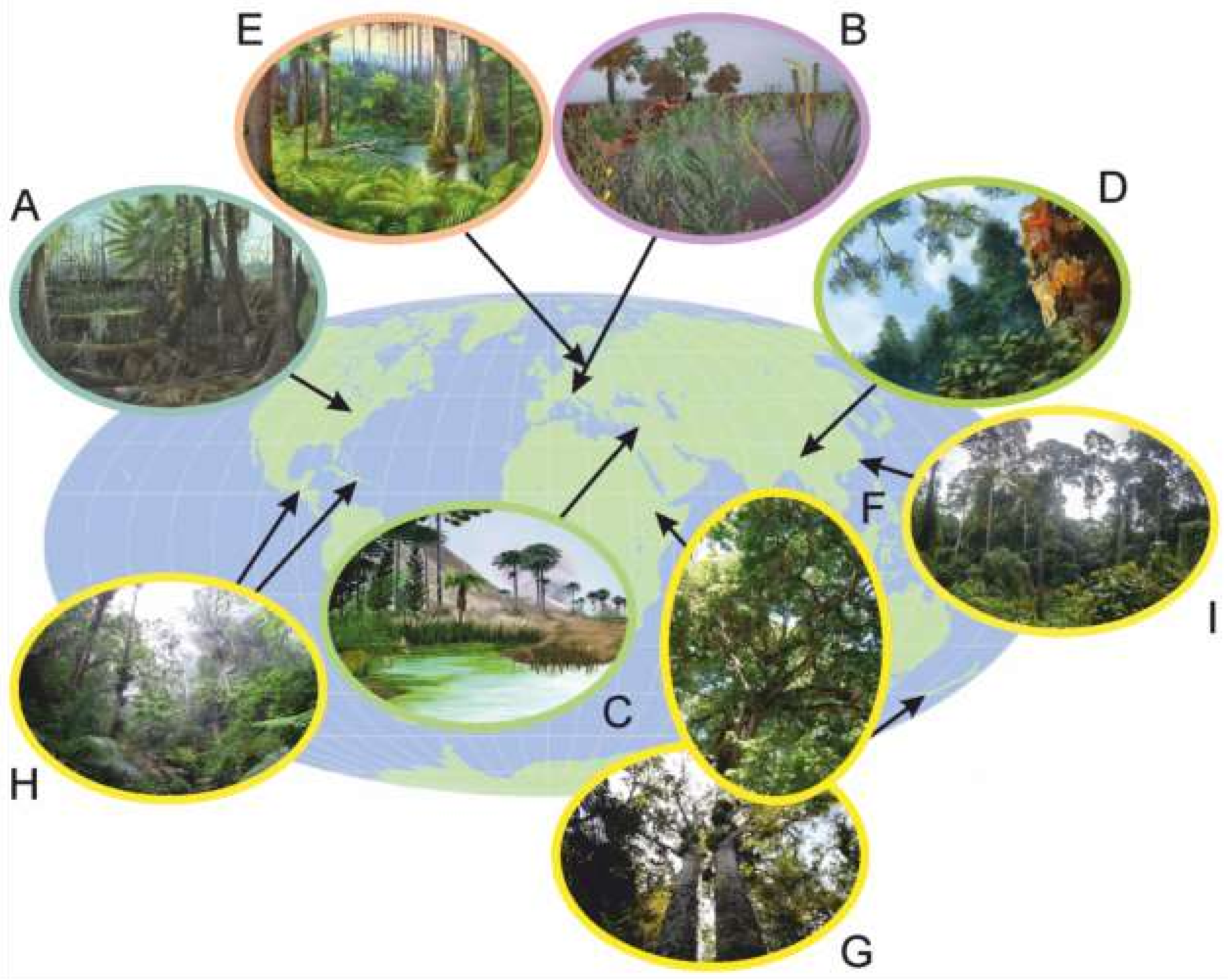

Fig. 1. Distribution of assorted fossil resins deposits. A – Carboniferous, Mississippian, Illinois; B – Triassic, Carnian, The Dolomites; C – Lower Cretaceous, Barremian, Lebanon; D – 'mid-Cretaceous', Kachin; E – Eocene, Gulf of Gdańsk; F – Amhara, Ethiopia; G – Otago, New Zealand; H – Mexican and Dominican amber; I – Zhangpu, China.

Fossil resins from different periods and regions are rich sources of inclusions, representing new extinct species and yielding important insights into the evolution of various organisms in the dimension of time. Evolutionary transitions can be well-documented by fossil resins inclusions, and inclusions can reveal anatomical transformations and the age of appearance of structural features. Inclusions contribute to understanding the phylogeny, biology, and biogeography of animals, fungi and plants. Fossil resins and inclusions embedded in them are of capital importance for dating molecular affinity trees. Reconstructing evolutionary processes that occurred in the distant past benefits from integrating molecular and morphological information from extant and fossil taxa, with total-evidence analyses[27].

Another major potential of fossilized resins and entombed inclusions is the documentation of faunal, floristic and climatic shifts. This plethora of new discoveries, new research, and reinterpretations of existing data significantly impact how we view fossil resins deposits. Many of the newly discovered sites are accurately dated, and sometimes, the botanical origin of fossilized resin is also known. Renewed interest in fossilized resins is now resulting in attempts to use them as proxies for reconstructing palaeoenvironmental conditions, reconstructing palaeoecosystems. Inclusions of all types, bioinclusions as tiny arthropods, other animals and their fragments, plants and their fragments, fungal hyphae, spores, pollen and other microinclusions, inorganic inclusions, ichnofossils related to fossil amber – all these data are essential to understand and reconstruct palaeohabitats, their conditions and functioning.

The fossil record is notoriously imperfect and biased in representation, the fossil record of resins and inclusions in the fossil resins, however, can bring some hope in the interpretation of evolutionary and environmental changes. Fossil resins have witnessed major global changes, the resins themselves, together with inclusions in the resins, were formed at various moments in the history of the Earth and documented the World at that time. The resins and the inclusions encapsulated in them are microworlds and witnesses of the Earth's past biotas.

References

1. Ragazzi E., Schmidt A.R. 2011: Amber, in Reitner J., Thiel V. (Eds) Encyclopedia of geobiology. Springer; doi:10.1007/978-1-4020-9212-1_9
2. Seyfullah L.J. et al. 2018: Biol. Rev., 93 (3), 1684–1714; doi:10.1111/brv.12414
3. Solórzano-Kraemer M.M. et al. 2020: Sci. Rep., 10, 19904; doi:10.1038/s41598-020-76808-6
4. Szwedo J. 2002: Denisia, 04, 37–56.
5. Dal Corso J. et al. 2020: Sci. Adv., 6, eaba0099; doi:10.1126/sciadv.aba0099
6. Zhang P. et al. 2023: Front. Ecol. Evol., Sec. Paleoecology, 11, 1199121; doi:10.3389/fevo.2023.1199121
7. Maksoud S. et al. 2022: Carnets Geol. 22 (16), 699–743; doi:10.2110/carnets.2022.2216
8. Moreau J.-D. et al. 2017: Geodiversitas, 39 (4), 729–740; doi:10.5252/g2017n4a5
9. Arillo A. 2012: Life in Cretaceous amber forest of Spain, in Pytlos R. et al. (Eds) 7th Session of the World Amber Council, 18–19 May 2012, Gdańsk. Mayor's Office for City Promotion, City Hall of Gdańsk.
10. Ross A.J. 2023: Palaeoentomology, 6 (1), 220–40; doi:10.11646/palaeoentomology.6.1.6
11. Lloyd G.T. et al. 2008: Proc. Biol. Sci., 275 (1650), 2483–2490; doi: 10.1098/rspb.2008.0715

12. Grimaldi D.A., Nascimbene P.C. 2010: Raritan (New Jersey) amber, in Penney D. (Ed) Biodiversity of fossils in amber from major World deposits. Siri Scientific Press.

13. McKellar R.C, Wolfe A.P. 2010: Canadian amber, in Penney D. (Ed.) Biodiversity of fossils in amber from the major World deposits. Siri Scientific Press.

14. Perkovsky E.E., Vasilenko D.V. 2019: Paleontol. J., 53 (10), 984–993; doi:10.1134/S0031030119100149

15. Zhang D. et al. 2018: Nat. Commun., 9, 3170; doi:10.1038/s41467-018-05650-2

16. Néradeau D. et al. 2017: Cretac. Res. 70, 77–95; doi:10.1016/j.cretres.2016.10.001

17. Nel A., Brasero N. 2010: Oise amber, in Penney D. (Ed.) Biodiversity of fossils in amber from the major World deposits. Siri Scientific Press.

18. Singh H. et al. 2022: J. Geol. Soc. India 98, 661–668; doi:10.1007/s12594-022-2042-x

19. Szadziewski et al. 2018: Baltic amber – treasure of the Bay of Gdańsk. Związek Miast i Gmin Morskich

20. Kosmowska-Ceranowicz B. 2017: Amber in Poland and in the World. WUW.

21. Iturralde-Vinent M.A., MacPhee R.D.E. 2019: Palaeoentomology, 2 (3), 236–240; doi: 10.11646/palaeoentomology.2.3.7

22. Riquelme F. et al. 2014: MRS Online Proc. Lib. 1618, 169–180; doi:10.1557/opl.2014.466

23. Wang B. et al. 2021: Sci. Adv., 7 (18), eabg0625; doi:10.1126/sciadv.abg0625

24. Nang L.N. et al. 2022: Gems Gemol., 58 (2), 184–194; doi:10.5741/GEMS.58.2.184

25. Bouju V., Perrichot V. 2020: Bull. Soc. Geol. Fr., 191 (17), 1–11; doi:10.1051/bsgf/2020018

26. Stilwell J.D. et al. 2020: Sci. Rep., 10, 5703; doi:10.1038/s41598-020-62252-z

27. Koch N.M, Parry L.A. 2020: Syst. Bio., 69 (6), 1052–1067; doi:10.1093/sysbio/syaa023

NOTES

BALTIC AMBER – TRAP OR TREASURE TROVE FOR PALAEOBIOLOGY

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Keywords: fossil resin, Eocene, environmental palaeoreconstructions, data interpetation

The Eocene, a geological epoch that lasted from about 56 to 33.9 million years ago, is the most biologically significant event of Cenozoic climate change, when the climate of Earth shifted from an equable greenhouse to a polarised icehouse. The snapshots of that times had been captured as inclusions in fossilised resins. The best known and the largest elaborated is a complex of fossilised resins known under umbrella term 'Baltic amber'. If the term is perfect for jewellery makers, for research it should be taken with some reservations.

The largest amount of these resins come from various secondary deposits, mostly found on the southern coasts of the Baltic Sea, from Estonia in the northeast to Denmark in the northwest. The most prolific source is the Gulf of Gdańsk deposit, spread from the Sambia Peninsula in the east to Chałpowo, at the base of the Hel Peninsula in the west. Here the resins are to be deposited in glauconitic marine sediments called the 'Blue Earth'. Sambian amber-bearing deposits are placed in the lower portion of the Prussian Formation, aged Late Eocene (Priabonian). The fossil resin collectively recognised as 'Baltic amber' is to be found very far to the north, in Spitsbergen, on Axel Heiberg Island in the Canadian Arctic, or on the east coast of the British Isles. Glaciers spread the amber to the south, to the foreland of the Carpathian mountains. Other deposits could result from glacier activity as well, as most of those in Lithuania and Belarus. It remains unclear whether 'Baltic amber' found in the different regions can be treated as being of the same origin[1,2].

Other important deposits of fossil resins are those of the Bitterfeld area. The oldest fossil resin (succinite) was found under the Upper Eocene lignite seam Bruckdorf west of Bitterfeld; it is thus about the same age as the amber of the Blue Earth of Sambia. Other individual finds come from the seam level of the Lower Oligocene near Breitenfeld north of Leipzig and near Böhlen. In the entire Leipzig-Bitterfeld area, more than 500 amber deposits of Upper Oligocene age were found on an area of 20 square kilometers[3].

Another important source is fossil resins from Ukraine, originating from Rovno-Zhitomir area. The fossilized resins are hosted in the Priabonian Mezhigorje Formation, with early reports of occurrences in the underlying Obukhov Formation as well[4]. The formations are found along the northwestern margin of the Ukrainian Crystalline Shield exposed in the Rivne region of the Ukraine and across the border near Rechitsa in the Gomel Region of Belarus.

But what is behind the collective 'Baltic amber' resins? The vast majority of fossilised resin from these three major deposits and numerous other localities is identifiable as succinite, with a characteristic shape of FT-IR spectrum called 'Baltic amber shoulder'. This kind of resin is the most variable in coloration and transparency, and this one is the one usually containing inclusions. In all deposits, there are also other accessory resins, occurring together with succinite, e.g. gedanite, glessite, beckerite and stantienite, present in various amounts; the most diverse (at least the best elaborated) are those from the Bitterfeld area. These resins are important source of information, however, as they can have different botanical origin. Botanical origin of succinite and some other accessory resins is still subject of discussions[5]. Geochemical data clearly indicate that Bitterfeld and Baltic amber are not identical[6]. Geochemical evidence for the distinct origin of Rivne and Baltic amber deposits was also recently presented[7].The age of the deposit is not age of fossil resins contained – this reservation is often overlooked in analyses and interpretations of 'Baltic amber'. Most important deposits are secondary, amber could be (much) older than deposit. Further hurdles are linked to the physical properties of these fossilized resins. Once reworked from the original sediment, they may float or drift in sea water, even specimens forming large deposits may have been repeatedly reworked and transported by ancient rivers and sea currents, originally belonging to older and possibly geographically distinct sediments[8]. The probable broad range of the ancient amber producing forests and their presumed existence for several million years adding controversies to the image. These reservations are well known, but there are several other traps for researchers[1].

Eocene 'Baltic amber' is unequalled as Konservat-Lagerstätte, as a place of exceptionally rich and well-preserved fossil organisms. Its importance for scientific study is not to be overestimated. Hundreds of thousands of inclusions were found in Baltic amber, with >3800 species described from Baltic amber[2] and nearly 800 species reported from Bitterfeld amber[3]. The results of Baltic amber investigations are used in the taxonomy and phylogenetics of plants and animals, palaeobotany, palaeobiogeography, palaeoecology, palaeoclimatology,… Fossil resins are prime examples of chemical fossils that are relatively resistant to diagenesis and can retain their original chemical and isotopic compositions, which may support the detection of the resin-producing plants and the reconstruction of the palaeoenvironment and palaeoclimate[9]. Inclusions comprise many groups of organisms, from bacteria to vertebrates, which typically derive from forest ecosystems where they became embedded in resin outpourings in their habitats[10]. Being conscious of all problematic issues, 'Baltic amber' is still an important source of fossils for science and research. With new analytical techniques applied to the resins and their deposits, with new techniques for observation and documentation of fossil resins inclusions, with more taxonomic data enabling more detailed statistical comparisons of inclusions from various deposits, with a better understanding of taphonomic and diagenetic processes, the volumes of Baltic amber books are to be deciphered and translated into modern science language.

References

1. Szwedo J., Sontag E. 2009: Denisia, 26, 155–169.
2. Szadziewski R. et al. 2018: Baltic amber – treasure of the Bay of Gdańsk. Związek Miast i Gmin Morskich
3. Rappslilber I. 2022: Bitterfeld Bernstein. Ampyx.
4. Perkovsky E.E. et al. 2010: Rovno amber, in Penney D. (Ed) Biodiversity of fossils in amber from the major World deposits. Siri Scientific Press.
5. Sadowski E.-M. et al. 2017: Stapfia, 106, 1– 73.
6. Wolfe A.P. et al. 2016: Rev. Palaeobot. Palynol., 225, 21–32; doi:10.1016/j.revpalbo.2015.11.002
7. Mänd K. et al. 2018: Palaeogeogr. Palaeoclomatol. Palaeoecol, 505, 265–273; doi: 10.1016/j.palaeo.2018.06.004
8. Weitschat W., Wichard W. 2010: Baltic amber, in Penney D (Ed) Biodiversity of fossils in amber from the major World deposits. Siri Scientific Press.
9. Dal Corso J. et al. 2017: Geochim. Cosmochim. Acta 199, 351–369; doi:10.1016/j.gca.2016.11.025
10. Seyfullah L., Schmidt A.R. 2015: Palaeontology Online, 5, 12, 1–11.

PARASITOID WASP DIVERSITY (HYMENOPTERA) IN LOWER CRETACEOUS AMBER FROM EL SOPLAO (SPAIN)

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Keywords: Parasitoidism, paleoecology, paleodiversity, Mesozoic, Spanish amber

Hymenoptera are holometabolous insects corresponding to the fourth most diverse insect order. Based on phylogenetic studies, Hymenoptera are placed as sister group to the rest of holometabolous insects[1]. Traditionally, the order Hymenoptera comprises the groups 'Symphyta' and Apocrita. Within the Apocrita, 'Parasitica' and Aculeata are considered. However, both 'Symphyta' and 'Parasitica' have been found to be paraphyletic groupings[1]. The 'Parasitica' were grouped together based on the parasitoid biology, although some groups of Aculeata also show this mode of life, and not all groups within 'Parasitica' are parasitoids. Parasitoidism is a type of parasitism characterized by an adult stage with free dispersive mode of life and a larval stage that is parasitic and feeds on its host[2]. Up to 10 insect orders contain parasitoid representatives, but the 75% of parasitoid species are part of Hymenoptera. Parasitoidism is considered to have arisen one time in Hymenoptera and it is the dominant mode of life of this group since Late Triassic[1,2,3]. Other modes of life present in Apocrita arose secondarily. Wasps belonging to groups currently parasitoid are abundant and diverse in Cretaceous ambers, probably related to the small size of the individuals in this group, facilitating their trapping in resin. Nonetheless, it is important to note that to prove a behavior or mode of life for extinct representatives requires extensive research, although parasitoidism is usually considered based only on phylogenetic inference.

Here, we review the hymenopteran diversity in El Soplao amber, mostly composed of putative parasitoid forms, and comment the new findings and the next stablished research lines. El Soplao amber-bearing outcrop is located in the western part of the Basque-Cantabrian Basin (Cantabria, northern Spain), and it is dated as middle Albian (Lower Cretaceous)[4]. The order Hymenoptera is represented by 276 specimens in El Soplao amber, although only a few of them have been studied so far. Four species have been identified[5]: *Cretevania soplaensis* (Evaniidae), *Archaeromma hispanicum* (Mymarommatidae), *Microserphites soplaensis* (†Serphitidae), and *Megalava truncata* (Megalyridae). Furthermore, the families Bethylidae, Braconidae, †Maimetshidae, Scelionidae, and †Stigmaphronidae are also present. All these taxa have been considered parasitoid. New findings are two specimens belonging to the family Baeomorphidae (previously named Rotoitidae). This is a very rare group restricted to the Australasian and Neotropical realms today, but represented by several species in Cretaceous ambers from Canada, Russia, and Myanmar. The Mymarommatoidea and †Serphitoidea are under study, with new specimens being preliminary identified within the families †Alavarommatidae, †Gallorommatidae, Mymarommatidae, and †Serphitidae, as well as in Evaniidae. A remarkable amber piece contains six species belonging to the five families Baeomorphidae, Mymarommatidae, Scelionidae, †Serphitidae, and †Stigmaphronidae, showing a glance to the diverse parasitoid wasp community in the Cretaceous resiniferous forests. The study of the Hymenoptera in El Soplao amber will provide new information on the diversity and disparity of this group during the Early Cretaceous. Furthermore, it is planned to delve into the autecology of the Cretaceous parasitoid wasps and, particularly, to explore the evolution of parasitoid mode of life in extinct groups of alleged parasitoid wasps.

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References

1. Peters R.S. et al. 2017: Curr. Biol., 27, 1013–1018; doi:10.1016/j.cub.2017.01.027
2. Labandeira C.C., Li L. 2021: The history of insect parasitism and the Mid-Mesozoic Parasitoid Revolution in De Baeths K., Huntley J.W. (Eds) The evolution and fossil record of parasitism: identification and macroevolution of parasites. Springer; doi:10.1007/978-3-030-42484-8_11
3. Blaimer B.B. et al. 2023: Nat. Commun., 14, 1212; doi:10.1038/s41467-023-36868-4
4. Najarro M. et al. 2009: Geol. Acta, 7 (3), 363–387; doi:10.1344/105.000001443
5. Pérez-de la Fuente R. et al. 2012: Zootaxa, 3514 (1), 70–78; doi:10.11646/zootaxa.3514.1.4

A GLIMPSE TO THE ANCIENT RESINIFEROUS FORESTS THROUGH AMBER TAPHONOMY

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Keywords: resin, amber, paleoenvironment, palaeoecology, taphonomy

Resins are substances produced by specialized plant cells with a composition consisting of a complex mixture of terpenoids, both volatile and non-volatile, phenols and other compounds[1]. Other plants secretions are gums, mucilages, waxes, fats, and latex, some of which are also present in the fossil record[1]. The resin-producing plants are members of the conifers and angiosperms. Today, at least 66 genera of conifers (in seven families) and 153 genera of angiosperms (in 29 families) include resinous species[1]. However, only species belonging to a few genera produce resin in abundance, such as the conifer *Agathis* (family Araucariaceae) and the angiosperm *Hymenaea* (family Fabaceae). Traditionally, resin is considered to be a defensive and protective substance produced due to stressful environmental conditions after abiotic or biotic factors[1,2]. Amber is fossil resin, i.e. resin pieces that underwent amberization process[2,3]. The oldest known fossil resin dates from the Carboniferous, and the oldest amber with bioinclusions (organisms included within defaunation resin, copal, or amber pieces) is from the Triassic, although amber became abundant since the Early Cretaceous[2].

Here, we present new information on amber taphonomy and show the importance of taphonomic studies on amber to know the ancient resiniferous forest ecosystems based on Cretaceous ambers in general, focusing on Spanish ambers in particular. Data about more than 300 Cretaceous amber-bearing outcrops worldwide have been gathered, showing biases that hinder analyses from a global perspective. In general, amber localities from this period are numerous since the Barremian and relegated to some regions of the Northern Hemisphere; Cretaceous amber localities from the Southern Hemisphere being rare. These facts might be related to the global environmental conditions promoting resin mass production in certain regions and ages and/or sampling bias of amber localities. Amber-bearing outcrops usually yield a combination of root amber pieces, related to resin produced in the roots (in confined conditions), and aerial amber pieces, related to resin produced in the branches or trunk[2]. Understanding the difference between these kinds of amber pieces is important, as namely aerial amber contains bioinclusions. Actuotaphonomic experiments on organism trapping in natural resin and sticky traps provide data on diversity comparisons[4]. Furthermore, stratigraphic study (including dating based on microfossils) and taphonomic analyses on amber pieces is essential to know their autochthonous, parautochthonous, or allochthonous nature. All this information, together with data on other fossils in the amber-bearing rocks, is key to reconstruct the resiniferous forest ecosystems and delving into the factors promoting resin mass production. The case of Ariño amber (early Albian, eastern Spain) is unique worldwide based on the mostly autochthonous origin of the amber pieces, the presence of in situ root amber pieces, the richness of bioinclusions, and the data about other fossils (including dinosaurs) from the amber-bearing rock, allowing a detailed paleoecological reconstruction[5]. Other amber-bearing outcrops from Spain, such as El Soplao, have also been studied from a taphonomic perspective, indicating a parautochthonous origin with marine influence.

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References

1. Langenheim J.H. 2003: Plant resins: chemistry, evolution, ecology, and ethnobotany. Timber Press.
2. Martínez-Delclòs X. et al. 2004: Palaeogeogr. Palaeoclimatol. Palaeoecol., 203 (1-2), 19–64; doi:10.1016/S0031-0182(03)00643-6
3. Solórzano-Kraemer M.M. et al. 2020: Sci. Rep., 10, 19904; doi:10.1038/s41598-020-76808-6
4. Solórzano-Kraemer M.M. et al. 2018: Proc. Natl. Acad. Sci. U.S.A., 115 (26), 6739–6744; doi:10.1073/pnas.1802138115
5. Álvarez-Parra S. et al. 2021: eLife, 10, e72477; doi:10.7554/eLife.72477

NOTES

HANDSOME FUNGUS BEETLES (COCCINELLOIDEA: ENDOMYCHIDAE, ANAMORPHIDAE) IN MYANMAR AMBER. REMARKABLE DIVERSITY, REMARKABLE CHALLENGES

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Keywords: diversity, phylogeny, evolution, burmite, fungivory

The handsome fungus beetles (Coccinelloidea: Endomychidae, Anamorphidae, Eupsilobiidae and Mycetaeidae) include nearly 1800 known species of predominantly fungivorous habits. The precise phylogenetic relations of these lineages and their closest relatives, Coccinellidae and Corylophidae are still unclear and incompatible hypothesis between morphology and molecular-based analyses exist[1, 2]. The most adequate approach to finding a robust evolutionary hypothesis that includes its temporal dimension, is to build a comprehensive dataset that includes molecular information as well as morphological characters of extant and fossil species.

Fossil taxa of handsome fungus beetles have been poorly studied and understood. Only 15 species of Endomychidae *sensu stricto* have been formally described to the present. Eight species have been described from Cenozoic amber deposits (Eocene Baltic, Bitterfeld, and French amber from Oise).

Even more intriguing and systematically significant fossil taxa from come from Mesozoic deposits, particularly from the amber from northern Myanmar from the early Upper Cretaceous (approx. 99 Ma). Four new genera were described by Tomaszewska et al.[3] and assigned to present days subfamilies of Endomychidae: *Cretolestes*, *Burmalestes* (Leiestinae), *Cretoparamecus* (Merophysiinae), and *Palaeomycetes* (Xenomycetinae). Later, Li et al.[4] described the genus *Rhomeocalpsua* that is considered *incertae sedis* within Endomychidae due to its particular combination of characters. Recently, the genus *Cretostenotarsus* was described from Myanmar amber and was inferred, based on a cladistic analysis of the morphology, to be part of the subfamily Endomychinae[5]. This genus represents the oldest known representative of the clade known as 'higher Endomychidae'. This group is characterized by their pseudotrimerous tarsi, which is found in the most diverse and conspicuous members of Endomychidae as well as in Coccinellidae. The tarsal structure of *Cretostenotarsus* is, however, of an intermediate position between 'higher' Endomychidae and the more 'basal' clades.

A remarkable diversity of unnamed taxa in families Endomychidae and Anamorphidae exist in the amber from Myanmar. These represent a variety of genera and species, much of them of uncertain affinities. A portion of this diversity can be assigned to already described genera while the majority are part of yet undescribed genera. In this contribution, we discuss the diversity, and possible systematic relations of described and undescribed handsome fungus beetles (Endomychidae and Anamorphidae) from Myanmar amber as well as the challenges for its study and use as calibration points in phylogenetic studies. The fauna of handsome fungus beetles from this deposit show trends in the development and structure of morphological features such as tarsi, antenna, and thoracic sclerites that tell us of a phase of radiation and evolutionary exploration. The deciphering of the evolutionary message implicit among this diversity of shapes and species poses an exciting challenge. Solving it would imply a better understanding of the mode and tempo of the evolution of different traits like aposematism, gregarism, association with social insects, fungivory and predation among the lineages of handsome fungus beetles and their closest relatives, the successful Coccinellidae.

Fig. 1. Collage of undescribed species of Endomychidae in Myanmar amber from the early Upper Cretaceous.

References

1. Tomaszewska W. 2005: Ann. Zool., 55 (Suppl. S1), 1–172; doi:10.1234/jdr.123.186

2. Robertson J.A. et al. 2015: Syst. Entomol., 40, 745–778; doi:10.1111/syen.12138

3. Tomaszewska W. et al. 2018: Cretac. Res., 91, 287–298; doi:10.1016/j.cretres.2018.07.001

4. Li Y.D. et al. 2022: Palaeoentomology, 5 (2), 146–154. doi:10.11646/palaeoentomology.5.2.7

5. Tomaszewska W. et al. 2018: Insects, 13 (8), 690; doi.org/10.3390/insects13080690

A FORGOTTEN WORLD: AMBER HARVESTMEN AS A WINDOW INTO PAST DIVERSITY

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Keywords: harvestman, amber, Eocene, Cretaceous

Living harvestmen represent the third largest order of arachnids following mites and spiders. Their modern diversity is, however, not reflected in the fossil record with only a small number of extinct harvestmen described. Most of their evolutionary history is still a mystery. Numerous undescribed harvestman fossils from major amber deposits including Baltic, Bitterfeld, Burmese and Rovno amber have become available for study. Fifty fossils from all four suborders (Cyphophthalmi, Eupnoi, Dyspnoi and Laniatores) have been examined and 28 represent new species. These finds reveal a number of unknown morphological characters, new calibration points for the harvestmen tree of life and new insights into the group's biogeographical history. Notable highlights include the first fossil belonging to the nemastomatid subfamily Ortholasmatinae from Eocene Baltic amber (a group today found in Asia and North America), the first eupnoid from Southeast Asian Burmese amber, a cyphophthalmid showing intriguing adaptations possibly for a partly aquatic lifestyle, and the first fossils of the infraorder Insidiatores (Laniatores) which support the hypothesis of a Gondwanan origin for the Burmese amber fauna.

NOTES

FOSSIL FLOWERS FROM MIOCENE ZHANGPU AMBER (CHINA)

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Keywords: synchrotron X-ray tomography, Mid-Miocene Climatic Optimum, 3D reconstruction, palaeobotany

The Miocene Zhangpu amber from China represents one of the world's richest amber biotas with more than 13 000 inclusions of arthropods, gastropods, plants and fungi[1]. Arthropods are the most common organisms and have already been intensively studied, whereas seed plant inclusions have not been investigated in detail yet. However, these plant inclusions are an important key to gain new insights into the vegetation and plant diversity of the amber source area, as well as the palaeoecological context of all the invertebrate inclusions.

Here, we present the first detailed studies of seed plant inclusions from Zhangpu amber, comprising four angiosperm flowers. Since their external features were not sufficient for identification and key characters were hidden, we analysed the fossils using synchrotron radiation-based micro-computed tomography (SRµCT). This non-destructive technique allowed visualizing inner floral organs that were not accessible using standard light microscopy (Fig. 1), and essential for taxonomic identifications. The morphological analysis of the fossil inclusions indicate that the flowers show most similarities to modern *Canarium* (Burseraceae[2]), *Cryptocarya* (Lauraceae) and *Byttneria* (Malvaceae), and may represent new fossil species. In addition, they are the first fossil flowers of those genera, which nowadays occur in pantropical regions of Southeast Asia where they are typical components of tropical rainforests.

These flower inclusions thus provide new insights not only into the palaeoflora diversity of the Zhangpu amber forest but also further support its current interpretation as a megathermal seasonal rainforest. Moreover, our study emphasizes the great benefit of using X-ray based methods for analysing plant inclusions in amber.

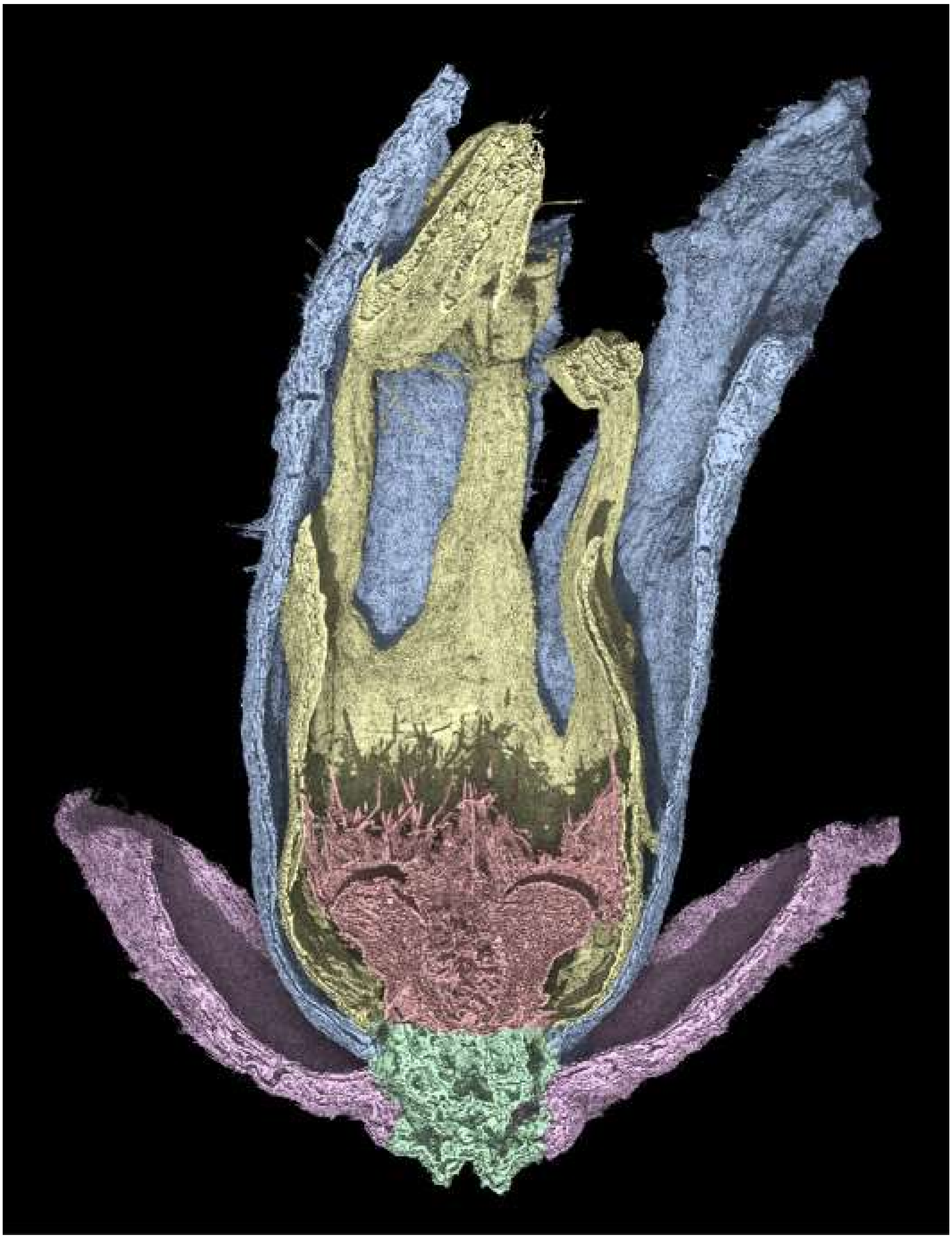

Fig. 1. Virtual 3D reconstruction from segmented SRµCT data showing the fossil flower of *Canarium* sp. nov. (in press) from Zhangpu amber in longitudinal section; note the pedicel (green), the synsepalous calyx (purple), the polypetalous corolla (blue), the androecium (yellow) and the nectary disk (red).

References

1. Wang B. et al. 2021: Sci. Adv., 7, eabg0625; doi:10.1126/sciadv.abg0625

2. Beurel S. et al. 2023: Palaeoworld, in press; doi: 10.1016/j.palwor.2023.02.006

LITHOBIOMORPHA IN BALTIC AMBER – CURRENT KNOWLEDGE AND PERSPECTIVES

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Keywords: Myriapoda, Chilopoda, Lithobiomorpha, Baltic amber

Lithobiomorpha is an order of rather small, anamorphic centipedes that includes around 1100 valid species within two families, mainly Laurasian Lithobiidae (this family includes well-known genus *Lithobius*) and Gondwanan Henicopidae[1]. Fossil record of this order is restricted to Cenozoic era and is represented mostly in Baltic amber. That includes three species described by Koch & Berendt in 1854[2]: *Lithobius longicornis*, *L. maxillosus*, *L. planatus* along with some *nomina nuda* mentioned by Menge[3], however, the exact status of these species is unknown and the material has not been re-examined until now[4]. After examining historical material, we summarize and update the current state of knowledge about Lithobiomorpha from Baltic amber, discuss the status of species that have been described in the past, and present all potentially new taxa that are the result of our investigation.

References

1. Edgecombe G.D., Giribet G. 2007: Annu. Rev. Entomol., 52, 151–170; doi:10.1146/annurev.ento.52.110405.091326
2. Koch C.L., Berendt G.C. 1854: Die im Bernstein befindlichen Crustaceen, Myriapoden, Arachniden und Apteren der Vorwelt. Nicol. Buch.
3. Menge A. 1854: [Footnotes to] Koch C.L., Berendt G.C. Die im Bernstein befindlichen Crustaceen, Myriapoden, Arachniden und Apteren der Vorwelt. Nicol. Buch.
4. Edgecombe G.D. 2011: 18 Chilopoda–Fossil history, in Minelli A. (Ed.) Treatise on Zoology-Anatomy, Taxonomy, Biology. The Myriapoda, 1, Brill. 355-361; https://doi.org/10.1163/9789004188266_019

NOTES

NEW INSIGHTS INTO THE JURASSIC COLEORRHYNCHA MYERS ET CHINA, 1929 (HEMIPTERA) FROM EUROPEAN DEPOSITS

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Keywords: *palaeoentomology, Jurassic, moss bugs, classification, fossil record*

The Coleorrhyncha Myers et China, 1929, commonly named moss bugs, are phytophagous insects of the order Hemiptera Linnaeus, 1758. The modern-day taxa are included in a family Peloridiidae Breddin, 1897 with a so-called Gondwanan distribution. The remaining families are known only from the fossil record – †Hoploridiidae Popov et Shcherbakov, 1991, †Karabasiidae Popov, 1985, †Progonocimicidae Handlirsch, 1906, and †Permoridiidae Burckhardt et al., 2022, the latter with taxonomic affiliation controversial. Known fossils record of these insects comes spans the Permian to Lower Cretaceous, with taxa described mostly from adpressional and compressional fossils, and rarely from Lower Cretaceous fossil resins (Lebanese amber, Burmese amber).

Progonocimicidae Handlirsch, 1906 is the largest family within the Coleorrhyncha, comprising 26 genera, from Australia, South America, Asia and Europe, from the Permian (Changhsingian) to the Cretaceous (Cenomanian). It is traditionally divided into two subfamilies, *viz*., Progonocimicinae Handlirsch, 1906 and Cicadocorinae Becker-Migdisova, 1958. The main difference between them is the structure of dScP vein, claval vein A_1, and claval fracture (Fig. 1).

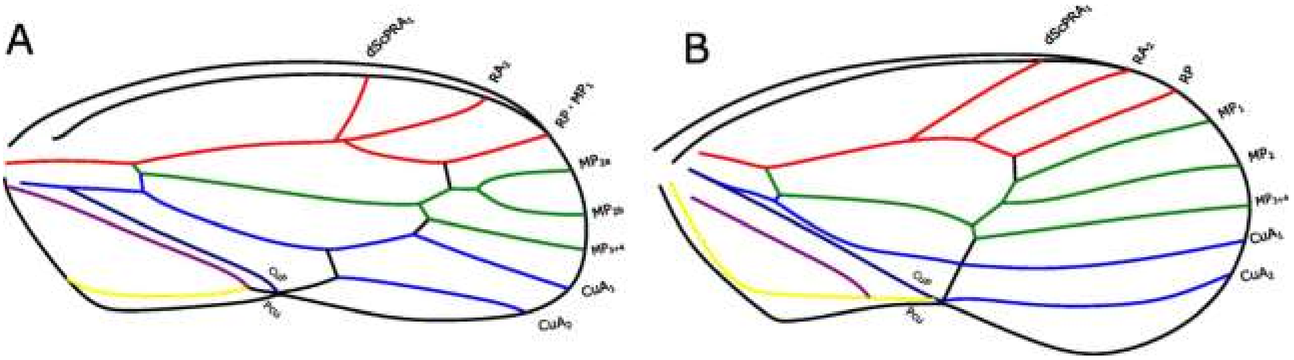

Fig. 1. Tegmen venation of A. Progonocimicinae *Actinoscytina belmontensis* Tillyard, 1926, B. Cicadocorinae *Mesocimex lini* Wang, Szwedo et Zhang, 2009. After WANG et al. 2009[5], modified.

The known Jurassic record of Progonocimicidae includes 68 species, of which only 6 European ones are assigned to the Progonocimicinae. The vast majority are included in the Cicadocorinae, but their distribution is restricted to Asia. In the fossil insects material from Germany, the Progonocimicidae represents 0.7-10% of all fossilized insects[1]. New material from the Jurassic of Germany (Grimmen) and Luxembourg (Bascharage) has revealed the first specimens of Cicadocorinae from Jurassic European deposits. These fossils present a set of new taxonomic and diagnostic features. The new specimens and the data resulting from them will facilitate work with vestigial material that is superior to complete specimens and allow revisionary studies.

The abundance and good state of preservation of specimens (often quite complete specimens, with preserved coloration and fine morphological details) may result due to their relative abundance in Jurassic palaeoecosystems and the taphonomic conditions under which they were subjected to fossilization. During the Jurassic era, around 183 Mya, the Toarcian Oceanic Anoxic Event (TOAE) occurred and it was probably the most extreme ocean deoxygenation event in the entire Phanerozoic[2]. The main factor responsible for these events were volcanic eruptions in the Karoo-Ferrar region and the resulting sharp increase in atmospheric carbon dioxide levels[3].

Environmental changes in forest habitats, their depletion and conversion from diverse ones to low-diversity assemblage, affected associated insects, including Progonocimicidae. The fossil record also suggests a significant increase in tropical cyclones intensity during the period of TOAE[4], which should also be taken into account in palaeoecological and taphonomic considerations. The taphonomic conditions prevailing in the deep-sea marine sediments into which organic remains drifted, the anoxia, and the lack of bacterial activity resulted in good preservation of their remains and thus an abundance of Coleorrhyncha fossils in the studied deposits.

References

1. Ansorge J. 2003: Acta. zool. cracov., 46 (suppl. 1), 291–310.
2. Kemp D.B. et al. 2022: Glob. Planet. Change, 212, 103782; doi:10.1016/j.gloplacha.2022.103782
3. Font E. et al. 2022: Sci Rep., 12, 4342; doi:10.1038/s41598-022-08269-y
4. Krencker F.N. et al. 2015: Earth Planet. Sci. Lett., 425, 120–130; doi:10.1016/j.epsl.2015.06.003
5. Wang B. et al. 2009: Sci. China Earth Sci., 52, 1953–1961; doi: 10.1007/s11430-009-0160-6

EXPLORING THE FOSSIL RESINS TAPHONOMY – PIDDOCKS INCLUSIONS AND ICHNOFOSSILS

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Keywords: Teredolites, Pholadoidea, ichnology, taphocoenosis, new taxa

This study focuses on fossil resins and their significance in understanding past ecosystems. Inclusions of piddocks from the Pholadidae family (Bivalvia, Pholadoidea) preserved in Miocene Chiapas amber[1] and borings preserved in Baltic amber serve as the model fossils of future reconstructions of the fossil resins taphonomy model. Piddocks, well-known for their ability to drill into various substrates, leave behind distinctive borings, known as ichnofossils[2,3]. This research not only sheds light on the piddocks preserved within the substrates they excavated but also expands our knowledge by including ichnogenus *Teredolites*.

A single piece of Chiapas amber from the Simojovel region was examined, revealing the presence of two bivalve specimens resembling pholadids. Among them, the larger and better-preserved specimen bears characteristics of a potential new genus and species. Additionally, the smaller specimen was identified as a new species belonging to the *Martesia* genus. Type of preservation of these fossils in lower Miocene fossil resin, providing significant taphonomical information about the origin of the Chiapas amber deposit alongside the basis for the palaeoecological reconstructions[1].

Moreover, this research considers numerous ichnofossils preserved in Baltic amber. Within this fossil resin, the ichnogenus *Teredolites* and its ichnospecies were discovered. *Teredolites* characterized by its distinctive borings, and behaviours of this wood-boring organism, provides insights into the distribution of Eocene fossil resins within their sedimentary basin. The study presents a combined examination of ichnofossils and inclusions, including their morphology, distribution patterns, and potential palaeoecological implications. Through this analysis, we propose brief reconstruction models of paleoenvironments and taphocoenosis of the various sedimentation basins.

References

1. Castañeda-Posadas C. et al. 2021: Rev. Mex. Biodivers., 92, e923600; doi:10.22201/ib.20078706e.2021.92.3600
2. Buntin R.C.C. et al. 2022: Palaios, 37, 53–72; doi:10.2110/palo.2020.074
3. Kelly S.R.A., Bromley R.G. 1984: Palaeontology, 27, 793–807.

NOTES

THE NEMATODE FOSSIL RECORD - INSIGHTS FROM BALTIC AMBER INCLUSIONS

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Keywords: Baltic amber, inclusions, Nematoda, Dauer larvae

This research is mainly focused on phylum Nematoda preserved in Baltic amber, on their fossil record as inclusions and their significance in understanding past ecosystems. Nematodes, have left traces of their presence dating back to the Devonian period, approximately 410.8 million years ago[1,2]. While many of these fossils are associated with plant or animal hosts, such as nematode eggs found in coprolites or phoretic larval stages, the fossil record of free-living nematodes remains limited[3,4].

The fossil record of nematodes comprises 49 genera and 91 species preserved as fossils or subfossils. Notably, 84 species have been described as inclusions in fossil resins, with a significant portion consisting of Dauer larvae juveniles associated with arthropods.

For this study, research material was obtained from Baltic amber pieces from the Collection of the Museum of Amber Inclusions at the University of Gdansk (MAIG). Nematodes were identified in ten pieces of amber, revealing the preservation of at least 104 specimens. We recognized a range of nematode forms, including Dauer larvae juveniles, possible eggs and representatives of free-living groups.

This study proposes interpretations of the habitats inhabited by various trophic groups of nematodes found within Baltic amber. Such insights are crucial for advancing nematological investigations and enhancing our understanding of the paleoecology of “amber forests”. Additionally, this research contributes to our knowledge of the conditions of preservation of inclusions within fossil resins.

References

1. Arillo A. 2007: Geol. Acta, 5, 159–166.
2. Kumar Y., Yadav B.C. 2020: Int. J. Res. Rev., 7, 379–386; doi:10.3126/janr.v4i2.33950
3. Poinar G. Jr., Buckley R. 2006: J. Invertebr. Pathol., 93, 36–41; doi:10.1016/j.jip.2006.04.006
4. Poinar G. O., Currie D. C. 2020: Nematology, 22, 655-658; doi:10.1163/15685411-00003328

NOTES

WHAT IS ETHIOPIAN AMBER TELLING US ABOUT MIOCENE AFRICAN FOREST ECOSYSTEM?

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The amber fossil record is distributed worldwide but mainly supported by Northern Hemisphere deposits. The Southern Hemisphere amber fossil record is relatively scarce, due to difficulties of access and prospection. The African continent recently revealed two new amber outcrops. Previously, fossiliferous and non fossiliferous copals were known from Africa, as well as older fossilised resins lacking fossil inclusions[1]. The Cretaceous resin from Congo, and the Cenozoic resin from Ethiopia, are the first African ambers known to display arthropod and botanical inclusions.

When first mentioned in 2010[2], the Ethiopian amber was suggested Cretaceous. This dating was rapidly questioned by the modern lineage taxa, described from the fossilized resin[3,4]. Those rather display a Cenozoic assemblage. Palynological data and field observations corroborate this revision and further indicate a Miocene age of the amber. The resin originates from an angiosperm, probably *Hymenaea* (Fabaceae), as suggested by its chemical signal, and the associated botanical inclusions. Cryptogam and arthropod inclusions (mainly Hymenoptera and Diptera) already display a large diversity of modern taxa. All together, fossilised specimens illustrate a subtropical, hot and humid, swamp forest ecosystem. Similarities with the botanical and entomofaunal composition of the contemporaneous Dominican and Mexican ambers, suggest an affinities between African and American Miocene ecosystems.

References

1. Bouju V., Perrichot P. 2020: BSGF – Earth Sci. Bull., 191 (17); doi:10.1051/bsgf/2020018
2. Schmidt A.R. et al. 2010: Proc. Natl Acad. Sci. U.S.A., 107 (16), 7329–7334; doi:10.1073/pnas.1000948107
3. Coty D. et al. 2016: Ann. Soc. entomol. Fr., 52 (3), 161–166; doi:10.1080/00379271.2016.1230477
4. Perrichot V. et al. 2016: The age and paleobiota of Ethiopian amber revisited, in 5th International Paleontological Congress.

NOTES

BUZZERS FROM THE PAST – THE FIRST MELIKERTINI BEE FROM EOCENE LUBLIN AMBER

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Keywords: fossil resin, Apidae, max 5 keywords, separated by commas

A new source of fossil resin with inclusions – Eocene amber from the Górka Lubartowska region (Lublin area, South Eastern Poland) has been recognized. It is a group of clastic deposits accumulated in the Middle and Late Eocene. Amber accumulations are found in marine sediments associated with regressive facies, deposited in a fairly low energy environment and is therefore the sedimentary equivalent of fine clastic formations. Amber bearing sediments are formations of the littoral zone or the shallow silicoclastic shelf[1]. Amber found in this area brought several inclusions not reported from similarly aged amber from the Gulf of Gdańsk, Bitterfeld or Ukraine.

Of all the world's bees (Hymenoptera: Apidae), there are none more iconic than the corbiculate bees. The corbicula, or pollen basket, is a specialization of the hind tibia for the transport of pollen, it is formed of a widening and flattening of the hind tibia. Corbiculate bees include the best recognized honey bees and bumble bees, and in tropical countries the familiar stingless bees and orchid bees in the New World[2]. The corbiculate bees form a distinctive monophyletic lineage in the nominate subfamily (Apinae) of the family Apidae. They comprise four extant lineages, each recognized as a tribe: Euglossini (orchid bees), Bombini (bumble bees), Meliponini (stingless bees), and Apini (honey bees)[2]. Interestingly, the corbiculate clade has a substantial fossil record, with its earliest occurrence near the end of the Cretaceous and three extinct tribes Electrobombini, Electrapini and Melikertini disappeared around the Eocene-Oligocene extinction event. These extinct corbiculate lineages include both highly eusocial and primitively eusocial groups, the tribes Electrapini and Melikertini, exhibiting morphologically specialized worker castes like those of Meliponini and Apini.

The tribe Melikertini comprises now 8 genera and 14 species. These bees superficially resemble stingless bees (Meliponini), with a general habitus similar to many small meliponine genera. However, Melikertini differs from Meliponini most noticeably by the complete wing venation (reduced in Meliponini), presence of a supraalar carina (absent in Meliponini), presence of an auricle (absent in Meliponini), absence of a penicillum (present in Meliponini), presence of a single metatibial spur (absent in Meliponini), toothed pretarsal claws, and presence of a well-developed sting (vestigial in Meliponini). Several Melikertini have unusual morphological modifications, peculiar upper extensions of the clypeal base that project upward between the antennae to varying degrees[3,4]. Here we present the first Melikertini bee from the amber of Górka Lubartowska, representing a new genus and species, also presenting facial modifications and set of other features clearly placing it among Melikertini, but as separate taxon. A piece of amber includes 3 complete and two incomplete specimens of bees representing the same taxon. The Darwinian null hypothesis and single origins of eusociality and highly eusocial behavior among corbiculate bees was presented[3]. Extinct corbiculate lineages include both highly eusocial and primitively eusocial groups, the tribes Electrapini and Melikertini, exhibiting morphologically specialized worker castes like those of Meliponini and Apini.

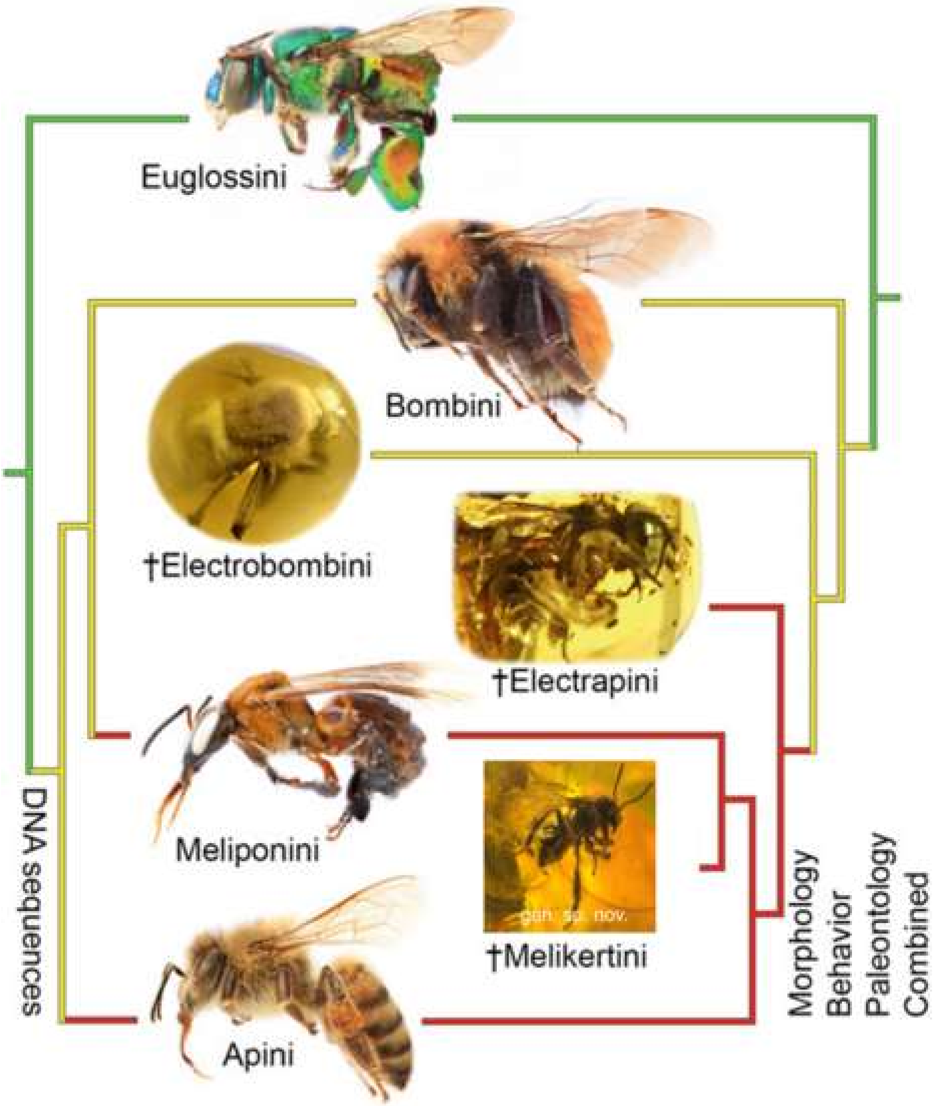
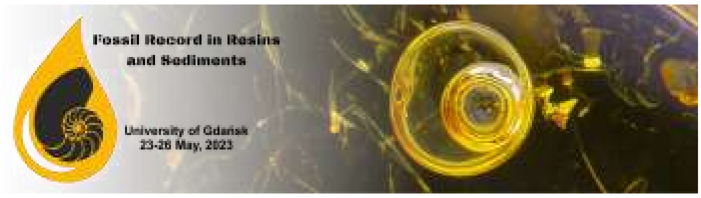


Fig. 1. Estimates of phylogenetic relationships among the tribes of corbiculate bees (After Engel M.S., Rasmussen C. 2020: Corbiculate bees, in Starr C. (Ed.) Encyclopedia of social insects. doi:10.1007/978-3-319-90306-4_30-1

References

1. Słodkowska B. et al. 2022: Prz. Geol., 70 (1), 50–60; doi:10.7306/2022.3
2. Michener C.D. 2007: The bees of the world (2nd ed.). Johns Hopkins University Press.
3. Engel M.S. 2001: Bull. Am. Mus. Nat. Hist., 259, 192, 1–123.
4. Engel M.S., Davis S.R. 2021: J. melittology, 103, 1–52; doi: 10.17161/jom.i103.15655



AMBER COLLECTION AT THE NATURAL HISTORY MUSEUM, LONDON

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Keywords: amber, fossil resin, inclusions, Natural History Museum London

The Natural History Museum in London houses approximately 80 million objects spanning 4.5 billion years from the formation of the solar system to the present day. The origin of this unique and esteemed institution was in 1753 following the death of Sir Hans Sloane who, driven by the desire to identify and classify the works of nature, had created an enormous collection. This formed the new British Museum collection set up for the inspection of the learned and the benefit of the public[1]. In 1755 Montagu House in Bloomsbury was chosen as a suitable home for the newly constituted British Museum and four years later the Museum was open to the public. In 1807 the new Department of Natural History and Modern Curiosities was set up. However, Montagu House was unable to cope with the growing collection and by 1841 the Museum's collections had been moved into the magnificent, purpose-built British Museum in Bloomsbury[1]. Richard Owen was appointed Superintendent of the Natural History Departments in 1856 and he fought and won the battle for a separate Museum of Natural History. The foundation stone was laid in 1873 in South Kensington and the building was completed in 1880. The Museum was officially opened one year later.

The Palaeontology Collection of the Natural History Museum holds approximately 5000 amber specimens, most of which contain inclusions. To date, less than 15% of this amber collection has been databased within the Museum's collections management system, but there is currently a digitization project aiming to capture and share data and images of the material. The collection is stored in fire-proof safes.

Paleogene Baltic amber, including material from Russia and Lithuania, along with occasional lumps washed up on the east coast of Britain, forms the largest part of the collection. There is also a large collection of Miocene amber from the Dominican Republic. Some of the oldest amber in the collections is from the Early Cretaceous of the UK (e.g., from near Hastings, East Sussex). Cretaceous Burmese amber from the Hukawng Valley of Myanmar within the collections includes the largest known piece in the world, over 50cm across. Other Cretaceous amber within the collection includes material from Lebanon and Japan. There is a small but significant collection of Oligocene amber from Mexico[2] and over 100 specimens of Oligocene Sicilian amber. There is a small number of specimens from other localities such as the Miocene of Borneo. The Museum's amber collection is rich in type material and includes holotype specimens of insects, arachnids, and plants. Some of these have been catalogued[2], but the current digitization project will make more information available. There are also about 400 amber specimens held within the Museum's Mineralogy collections. Most of these do not contain inclusions[3]. Here some of the earliest specimens added to the collections can be found, including amber from Sloane's collection.

References

1. Thackray J., Press B. 2013: Nature's Treasurehouse: A history of the Natural History Museum. NHM.

2. Ross A.J. et al. 2016: Bol. Soc. Geol. Mex., 68 (1), 45–55; doi:10.18268/BSGM2016v68n1a7

3. Ross A.J. 2004: Quekett J. Microsc., 39, 723–728.

NOTES

THE BEARING OF THE FOSSIL RECORD TO CONSTRAIN THE EVOLUTION AND EXTINCTION OF PARASITE-HOST ASSOCIATIONS

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Keywords: palaeoparasitology, palaeopathology, coprolite, amber, parasite-host associations

Parasitism is one of the most common modes of life, and yet the fossil record is often disregarded or ignored to understand its evolution and conservation[1]. We are currently at the brink of the sixth mass extinction and in order to assess the extinction risk of both parasites and their hosts[2], we first need to fully understand their evolution and potential insights from beyond their historical record. A survey of the fossil record shows that some modes of preservation show a higher potential for the preservation of parasite–host associations than generally recognized. A better understanding of the taphonomy of parasites is critical to better predict their preservation potential and, together with new modelling techniques, can provide crucial insights into their evolution and extinction[2,3]. Vertebrate coprolites have yielded remains of helminths as far back as the Permo-Carboniferous[4], but a more systematic screening of coprolites is needed and underway to make them a fruitful source of parasitic remains prior to the Holocene when such observations have been most abundantly reported. Amber deposits from the Cretaceous to Cenozoic are rich in terrestrial parasitic ecdysozoans and their pathogens including nematodes[3], but additional documentation and modelling techniques[5] are needed to understand changes across the Cretaceous-Paleogene mass extinction. For particular parasite–host associations, preservation of direct evidence is unlikely, but traces parasites leave in skeletons and other host remains can be successfully used to understand changes in their prevalence and strategies from the Paleozoic to the Cenozoic[5]. All analyses currently point to an increase of parasitism with biodiversity across the Phanerozoic. However, systematic screening of these sources including sample sizes and prevalence are underway and necessary to analyze changes and correct for sampling biases in parasite-host associations in high resolution across evolutionary crises (e.g., mass extinctions) or environmental perturbations (Quaternary warming events) in deep time.

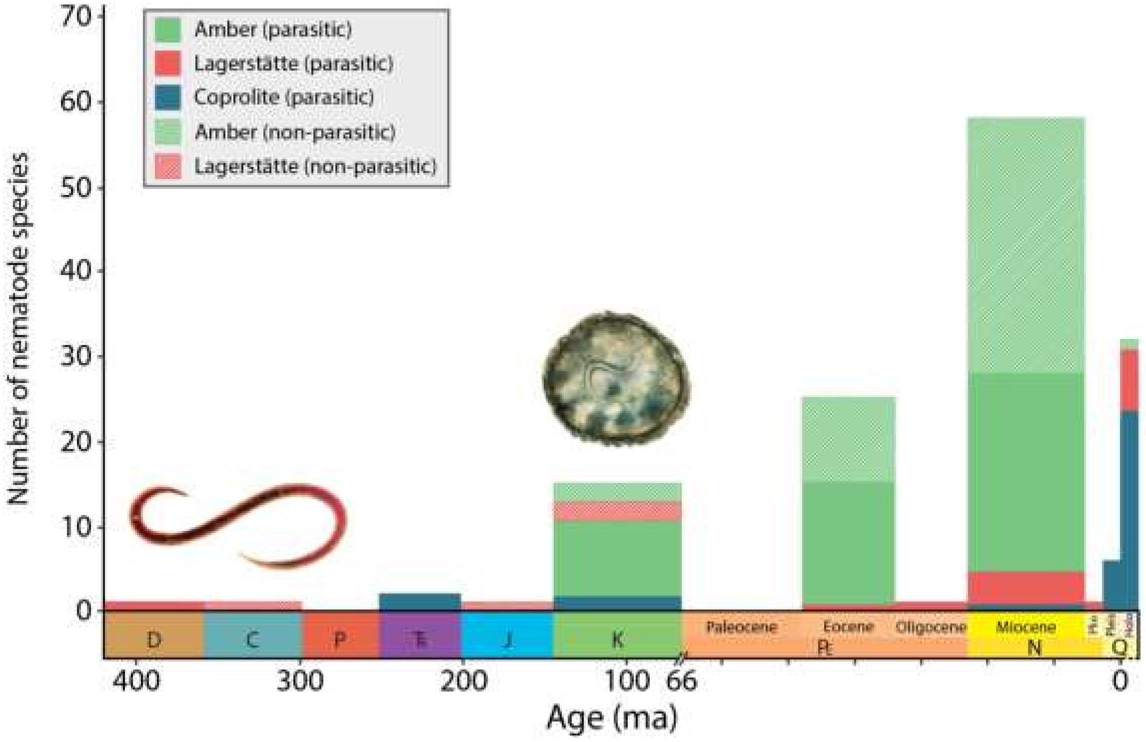

Fig. 1. Number of reported parasitic and nonparasitic nematode species from the Devonian through to Holocene; data updated from[2]. Abbreviations: D: Devonian, C: Carboniferous, P: Permian, T: Triassic, J: Jurassic, K: Cretaceous, PE: Paleocene, N: Neogene, Q: Quaternary. Reconstructions of the fossil nematodes *Palaeonema phyticum* (left) and *Ascarites priscus* (right) courtesy of Franz Anthony (https://franzanth.com/) – not to scale.

References

1. Strona G. 2015: Int. J. Parasitol. Parasites Wildl. 4, 431–441; doi:10.1016/j.ijppaw.2015.08.007

2. Mulvey L. et al. 2022: Proc. Royal Soc. B, 289, 20220432; doi:10.1098/rspb.2022.0432

3. De Baets K. et al. 2021: The fossil record of parasitism: its extent and taphonomic constraints, in De Baets K., Huntley J. (Eds) The evolution and fossil record of parasitism: coevolution and paleoparasitological techniques. Topics in Geobiology 50. Springer; doi:10.1007/978-3-030-52233-9_1

4. Chin K. 2021: Gastrointestinal parasites of ancient nonhuman vertebrates: evidence from coprolites and other materials, in De Baets K., Huntley J. (Eds) The evolution and fossil record of parasitism: coevolution and paleoparasitological techniques. Topics in Geobiology 50. Springer; doi:10.1007/978-3-030-52233-9_11

5. De Baets K. et al. 2021: Philos. Trans. R. Soc. Lond. B Biol. Sci., 376, 20200366; doi:10.1098/rstb.2020.0366

JUMPING PLANT-LICE (HEMIPTERA: STERNORRHYNCHA: PSYLLOIDEA) FROM EOCENE BALTIC AMBER

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Keywords: psyllids, Psylloidea, Baltic amber, Eocene

Psyllids or jumping plant-lice are a group of host-specific sucking phytophages comprising around 4000 species distributed throughout the world but are most diverse in tropical and subtropical areas[1]. They are associated almost exclusively with dicotyledonous plants, with a few species developing on monocotyledonous angiosperms and only four species on conifers. Psyllids damage plants by the removal of plant sap, stunting new growth, inducing galls or secreting honeydew and wax, an ideal substrate for sooty mould which reduces photosynthesis or by transmitting plant pathogens. Due to the last classification[1] superfamily Psylloidea Latreille, 1807 consists of seven families: Psyllidae Latreille, 1807, Aphalaridae Löw, 1879, Liviidae Löw, 1879, Triozidae Löw, 1879, Calophyidae Vondráček, 1957, Carsidaridae Crawford, 1911, Mastigimatidae Becker-Migdisova, 1973. Extant jumping plant-lice constitute a morphologically well-defined group. According to Drohojowska et al.[2,3] 2020, the stem-group of modern psyllids constitutes, the paraphyletic family Liadopsyllidae Martynov, 1926 from early Jurassic to late Cretaceous. Psylloidea are poorly represented in the fossil record and modern psyllids are documented in the fossil since the Eocene (Lutetian). Up till now the Eocene psyllids are represented only by 18 species, six genera of Psylloidea, all extinct and all belonging to the subfamily Aphalarinae (Aphalaridae Löw, 1879): *Carsidarina* Bekker-Migdisova, 1985, *Eogyropsylla* Klimaszewski, 1993, *Lapidopsylla* Klimaszewski, 1993, *Necropsylla* Scudder, 1890, *Proeurotica* Bekker- Migdisova, 1985 and *Protoscena* Klimaszewski, 1997[1,4,5]. Psylloidea diversity is higher in the Oligocene, with 15 genera belonging to all extant families.

The presented material is from Eocene Baltic amber, and includes 15 adult specimens (males and females), that belong to the family Aphalaridae and probably in 3 genera, two new and one known genera: *Eogyropsylla* Klimaszewski, 1993. All inclusions are from Collection Christel and Hans-Werner Hoffeins, Germany.

References

1. Burckhardt D. et al. 2021: Eur. J. Taxon.,736, 137–182; doi:10.5852/ejt.2021.736.1257
2. Drohojowska J. et al. 2020a: Sci. Rep., 10, 17607, doi:10.1038/s41598-020-74551-6
3. Drohojowska J. et al. 2020b: Sci. Rep., 10, 11390, 1–10; doi:10.1038/s41598-020-68220-x
4. Klimaszewski S.M. 1993: Acta biol. siles., 22, 9–18.
5. Klimaszewski S.M. 1997: Mitt. Geol.-Paläont. Inst. Univ. Hamburg, 80, 157–171.

Figure 1. *Eogyropsylla* sp. nov., body dorsal view.

CROUCHING DISPARITY, HIDDEN DIVERSITY – WHITEFLIES IN THE EOCENE RESINS OF EUROPE

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Keywords: fossil resins, Aleyrodidae, Aleurodinae, Aleyrodicinae, morphology

Whiteflies (Hemiptera: Sternorrhyncha: Aleyrodidae) are small insects, most species with a wingspan of less than 3 mm and a body length of 1 mm to 2 mm, but "giant whitefly" species exist, some of which may exceed 5 mm in size. Whiteflies name is due to the presence of powdery secretion preened over the bodies and wings of the adults of almost all species. These insects as larvae, puparia and adults typically feed on the undersides of plant leaves. Fossil record of Aleyrodidae reaches back to the Late Jurassic. Most of fossils known come from resins, including the first fossil described by Menge in 1856, under the name '*Aleyrodes*' *aculeatus* from the Eocene Baltic amber[1].

Family Aleyrodidae is usually divided into four subfamilies, extinct Bernaeinae, Aleyrodinae and Aleurodicinae, and the status of Udamoselinae is still disputable. Current classification of Aleyrodidae is mainly based on puparia, and disparity of imagines is very weakly recognized[2]. Contrary, fossil Aleyrodidae are mostly preserved as imagines, while fossilized puparia are very rare. Imagines of Aleyrodidae have well-developed antennae, which in most species in this family are seven-segmented; two ocelli, placed at the anterior margins of the compound eyes; compound eyes themselves are rather remarkable in recent taxa: many have a distinct constriction between the upper and lower halves, and in some species there is a complete separation; both sexes have functional mouthparts; two pairs of membranous, functional wings; the hind wings are neither much reduced, nor modified, but venation is scarce on both pairs; legs well developed and fairly long, but gracile; tarsi two segmented, tarsomeres subequal; the pretarsus composed of paired claws, with an empodium between[3]. One of unexplored area of morphological disparity of whiteflies is structure of thorax, which appeared to bear numerous useful taxonomically features[4].

The Eocene fossil resins of Europe comprise the Lowermost Eocene amber from Oise (Paris Basin, France) and younger resins collectively named 'Baltic amber', aged variously (Lutetian to Priabonian). The broad concept of 'Baltic amber' in respect to inclusions should be abandoned, as deposits were alimented from geographically independent sources. Current knowledge of Aleyrodidae from the European Eocene fossil resins counts 5 species from Amber of Oise (Aleurodicinae), 4 species from Gulf of Gdańsk amber (Aleurodinae and Aleyrodicinae), and one species from amber form Rovno (Aleurodicinae)[1]. In the material now at our disposal much more specimens are available, including first records of whiteflies from other localities in Europe. There are 19 inclusions in amber of Oise under elaboration. New material from Gulf of Gdańsk covers 114 specimens of Aleyrodinae and Aleurodicinae, partly elaborated, with at least 12 new taxa.

Inclusions from amber from Rovno covers 35 specimens under study now. There are two inclusions of Aleyrodidae from Bitterfeld amber, and another, new species is identified in amber from Lusatia. Amber collected in Denmark comprises 11 specimens representing a new genus with 7 species. These figures clearly indicate that taxonomic diversity and morphological disparity of whiteflies preserved in European resins is very high.

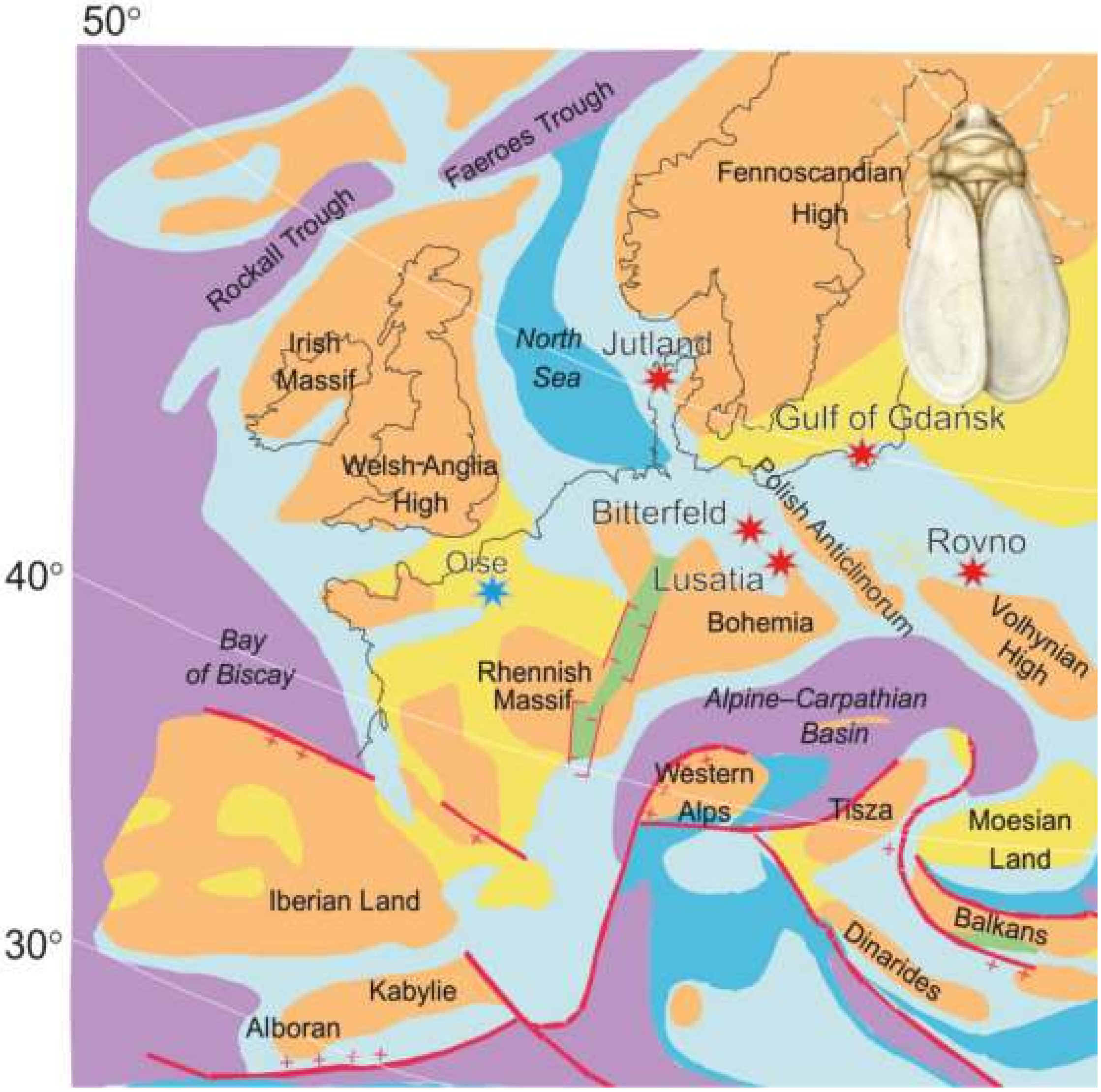

Fig. 1. Distribution of the Eocene fossil resins containing inclusions of Aleyrodidae.

References

1. Evans G.A. et al. 2023: Zootaxa (in press)

2. Szwedo J., Drohojowska J. 2016: Sci. Nat., 103, 35, 1–6+1–26; doi:10.1007/s00114-016-1359-y

3. Gerling D. 1990: Whiteflies: their bionomics, pest status and management. Intercept Ltd.

4. Drohojowska J., Szwedo J. 2011: Insect Syst. Evol., 42 (2), 179–196; doi:10.1163/187631211X568470

DINGLOMORPHA - KEY TAXON OR BLIND BRANCH IN STERNORRHYNCHA EVOLUTION?

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Keywords: fossil record, phylogeny, relationships, disparity, Hemiptera

The Sternorrhyncha is a suborder of the Hemiptera, which comprise about 18,700 described recent species. In the modern fauna, these tiny phytophagous insects comprise groups of great ecological and economic importance, like aphids (Aphidomorpha), scale insects (Coccidomorpha), whiteflies (Aleyrodomorpha) and psyllids (Psylloidea). Their evolutionary history can be traced back to the early Permian, but the early stages of their evolution and diversification are poorly understood. The consensus is that the Sternorrhyncha are a monophyletic lineage, but their internal classification is still an object of debate. Two extinct groups – Pincombeomorpha and Naibiomorpha were variously placed in classifications and relationship hypotheses, and Dinglomorpha appeared as a sister group to Aleyrodomorpha. Most of the recent Sternorrhyncha groups radiated rapidly during the Cretaceous, and Dinglomorpha is only known from the mid-Cretaceous, Cenomanian amber of Kachin, Myanmar[1,2]. Results of molecular investigations in Sternorrhyncha and Hemiptera were giving ambiguous results depending on sampling and due to long-branch attraction[3].

Morphological analysis of the Sternorrhyncha including the fossil groups[1] revised former opinions, placing the fossil groups in the context of their modern relatives. Two postulated lineages – Aphidiformes comprises [extinct Pincombeomorpha + [Coccidomorpha + [extinct Naibiomorpha + Aphidomorpha]]], and Psylliformes comprises [Protopsyllidioidea + [extinct Dinglomorpha + Aleyrodomorpha] + [extinct Liadopsyllidae + Psylloidea]]. These results clearly indicate that morphology should not be neglected in phylogenetic studies, and showed limitations of exclusively molecular approaches. Thus a new morphological and molecular and total evidence analyses are necessary to resolve existing contradictions. Dinglomorpha presents a mixture of characters shared with Aleyrodomorpha combined with unique features and sternorrhynchan symplesiomorphies. Thus it seems to be a key taxon to understand evolutionary traits in this lineage. The only dinglomorphan family, Dinglidae is represented by two monospecific genera: *Dingla* Szwedo & Drohojowska, 2020 and *Alloeopterus* Poinar et Brown, 2020, known from Cenomanian amber of Kachin. A few more inclusions from the same fossil resin, available for study, suggest that more taxa could be described, widening the range of morphological disparity of this group of sternorrhynchans. Dinglidae could be a relictual group, survived in particular conditions in the mid-Cretaceous archipelago of West Burma terrane. The West Burma terrane separated from Australia during the Jurassic and collided with Eurasia at ca. 80 Ma, so that Burmese amber may represent a mid-Cretaceous island flora and fauna with Gondwanan faunal elements[4]. This makes fossil Dinglidae even more interesting and important for diversity, disparity and phylogenetic studies. The oldest Aleyrodidae are known since the Jurassic of northern China, and these were quite dispersed during the Cretaceous[5]. The questions if Dinglidae have Gondwanan origin, their biogeographic status, the taxonomic and phylogenetic character remain open.

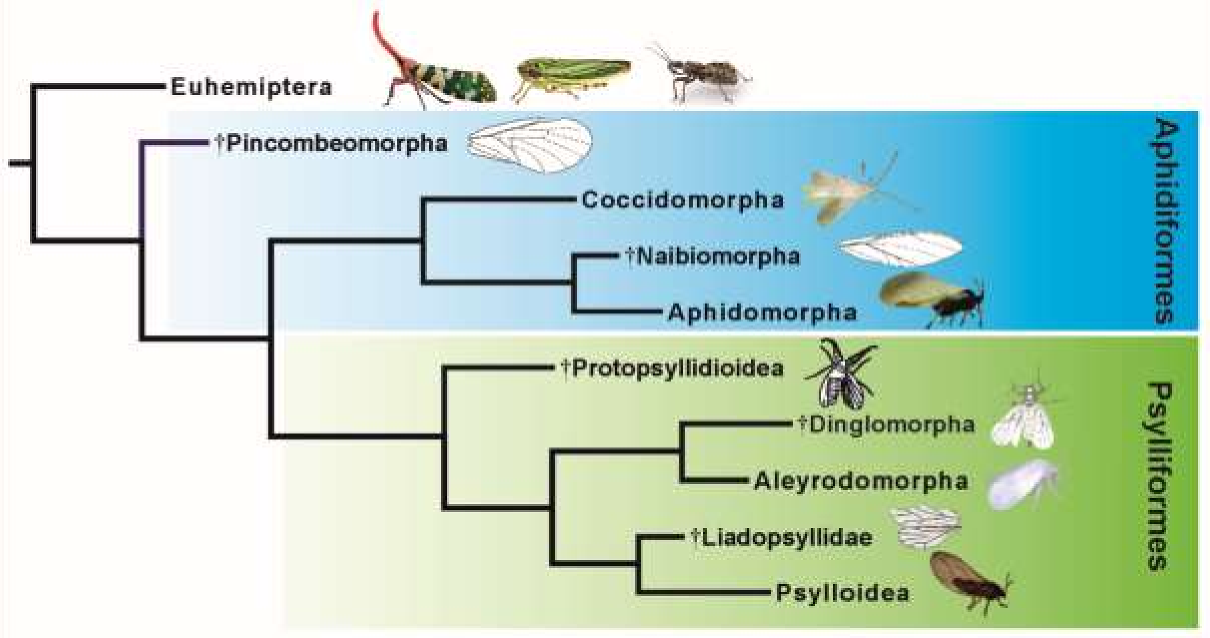

Fig.1. Relationships of major lineages within the Sternorrhyncha (Hemiptera).

References

1. Drohojowska J. et al. 2020: Sci. Rep., 10, 11390, 1–10; doi:10.1038/s41598-020-68220-x

2. Poinar G. Jr, Brown A.E. 2020: N. Jb. Geol. Paläont. Abh., 298 (3), 319–329; doi:10.1127/njgpa/2020/0951

3. Song N. et al. 2019: Mol. Phylogenet. Evol., 137, 236–249; doi:10.1016/j.ympev.2019.05.009

4. Wriedt A.-L. et al. 2021: J. Arachnol., 48, 311–321; doi:10.1636/JoA-S-20-017

5. Evans G.A. et al. 2023: Zootaxa (in press)

SEARCHING FOR CALIBRATION POINTS IN THE WORLD FOSSIL RESINS TO DATE THE LEPIDOPTERAN TREE OF LIFE

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Keywords: Lepidoptera, amber, calibration point, divergence time dating

In recent years, great advances have been made in the phylogenetics and -genomics of moths and butterflies (Lepidoptera), yet the timing of their evolutionary history remains unresolved because estimates vary according to different studies. Fossils can give clues about the timing of diversification events; however, the lepidopteran fossil record is known to contain numerous incorrect identifications. Many such identifications were made in the late 1800s or early 1900s, when the classification of Lepidoptera was very different to today, but more recent misidentifications are also abundant. Confounding this, identifications were often based on overall similarity to extant species, and not on apomorphies. To remedy this, an international group of experts has started verifying previous fossil identifications to find reliable calibration points to inform divergence time analyses[1–5].

Well-preserved lepidopteran fossils in sediments are extremely rare, but fossils in resins are relatively abundant. The great majority of such fossils are in Baltic amber, but inclusions in resins of other origins and ages are also known and could potentially be valuable as calibration points. Interesting discoveries have already been made and some recent results will be presented. However, examination of Lepidoptera trapped in amber is challenging because these insects have a dense scale cover hiding important diagnostic characters. Overcoming this obstacle, e.g. with µCT-scanning, is the next step in finding suitable specimens to robustly elucidate evolutionary timing within this enormous insect order.

References

1. De Jong R. 2017: Zootaxa, 4270, 1–63; doi:10.11646/zootaxa.4270.1.1
2. Doorenweerd C. et al. 2015: Zootaxa, 3963, 295–334; doi:10.11646/zootaxa.3963.3.2
3. Heikkilä M. et al. 2018: Zootaxa, 4394, 41–60; doi:10.11646/zootaxa.4394.1.2
4. Heikkilä M. et al. 2018: Zootaxa, 4483, 101–127; doi:10.11646/zootaxa.4483.1.4
5. Simonsen T.J. et al. 2019: PeerJ, 7, e7982; doi:10.7717/peerj.7982

NOTES

THE IMPACT OF NEW SCUTTLE FLY FOSSILS IN FOSSIL RESINS FROM CRETACEOUS TO HOLOCENE

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Keywords: Phoridae, fossils, palaeodiversity, Cenozoic, Cretaceous

The fossil resins are effective traps for insects, particularly for the small flies of Diptera family Phoridae. The resins facilitate exceptional preservation, including outstanding details of morphological structures, which are necessary to understand the evolutionary history and morphological adaptations of some taxonomic groups[1]. The scuttle flies, for example, exhibit phenomenal plasticity in terms of ecological adaptation, diet specialization and a wide range of hosts[2,3]. Despite being one the most abundant and diverse groups, scuttle flies are not well-known in the fossil record[4]. Many specimens are found in various amber and copal deposits, as well as Defaunation resin, between the Cretaceous and the Holocene periods, but have never been studied. Many institutions have had specimens of phorids in their collections for decades from various fossil resins, with some specimens pre-identified thanks to their characteristic wing venation, or identified only as Brachycera. Others are currently acquiring many new specimens from Burmese and Baltic ambers. Our first investigation of various institutions found a palaeodiversity at thousands of specimens identified as Phoridae, with most being from Eocene Baltic amber with over a thousand new specimens, followed by Mid-Cretaceous Burmese and Miocene Dominican amber with over a hundred new specimens. We selected the best new phorid specimens preserved in resin fossils from different geological ages and geographical distributions to fill the gaps in the fossil record (as Oise or Indian amber) and to better understand the palaeodiversity and evolution (as Burmese or Baltic amber) of selected Phoridae from Cretaceous to Holocene. We discovered many new species from extinct or extant genera (e.g. *Prioriphora*, *Euliphora*, *Dohniphora*, *Spiniphora*), as well as modern genera without a previous fossil record (e.g. *Kuenburgia*, *Rhopica*, *Rhynchomicropteron*), or even new genera. These new specimens indicate significant evolutionary changes between the Cretaceous and post-Cretaceous periods, which combined with ongoing studies are crucial for understanding the evolution of this group.

References

1. Grimaldi D., Engel M.S. 2005: Evolution of the Insects. Cambridge University Press.
2. Disney R.H.L. 1994: Scuttle flies: the Phoridae. Chapman & Hall.
3. Heraty J. 2017: Parasitoid biodiversity and insect pest management in Foottit R.G., Adler P.H. (Eds) Insect biodiversity: Science and society, Volume I, Second Edition, 603–625; doi:10.1002/9781118945568.ch19
4. Solórzano-Kraemer M.M. et al. 2023: Sci. Rep., 13, 2907; doi:10.1038/s41598-023-29612-x

NOTES

LISSOMINAE (COLEOPTERA: ELATERIDAE) FROM BALTIC AND ROVNO AMBERS

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Keywords: click-beetles, diversity, Elateroidea, Eocene, fossils

Elateridae, or click-beetles, are fairly abundant in Eocene European ambers. There are several described and numerous undescribed elaterid genera and species known from Baltic amber; however, the click-beetle fauna of Rovno amber is less known[1]. Lissominae are an interesting group of Elateridae, previously believed to form a subgroup of Throscidae or a separate family. They are divided into two tribes; relatively morphologically uniform Lissomini with a worldwide distribution (*Lissomus* Dalman, 1824, *Drapetes* Dejean, 1821, etc.) and much more morphologically diverse Protelaterini from the Australasian, Neotropic, Oriental, and East Palearctic regions (*Austrelater* Calder et Lawrence, 1993, *Protelater* Sharp, 1877, *Senodonia* Laporte, 1838, etc.). The monophyly of Lissominae and its both tribes is still contentious, and it should be noted that this subfamily is not supported by any adult synapomorphy[2].

Fossil record of Lissominae is scarce. *Lissomus taxodii* (Heer, 1870), described based on a part of isolated elytron from the Paleocene Firkanten Formation of Spitsbergen, Norway, was originally placed in Curculionoidea and only after more than a century it was transferred to *Lissomus*. Its systematic placement is, however, dubious[1]. In 2020, Kundrata et al.[3] described *Baltelater bipectinatus* Kundrata et al., 2020, the first representative of Lissominae from the Eocene Baltic amber. This enigmatic beetle had distinctive bipectinate antennae with 11 antennomeres and with rami beginning on antennomere IV, which are not present in any recent Elateridae. It was placed in Protelaterini.

In this contribution, we report the first three specimens of Lissominae from Baltic and Rovno ambers. They are probably conspecific and share small body (less than 3 mm), deep antennal cavities lying beneath the hypomera, and elongate trochanters. These characters suggest the studied specimens belong to Lissomini. Although Lissomini are characterized by the tarsomeres I–IV each with a long membranous lamella, these are not present in the here reported specimens. Our discovery not only significantly contributes to a better understanding of the palaeodiversity and evolution of Lissominae, but it is also further evidence that Baltic and Rovno ambers may include specimens of the same species.

References

1. Kundrata R. et al. 2021: Insects, 12, 286; doi:10.3390/insects12040286
2. Kundrata R. et al. 2019: Insects, 10, 231; doi:10.3390/insects10080231
3. Kundrata R. et al. 2020: Sci. Rep., 10, 20158; doi:10.1038/s41598-020-76908-3

NOTES

ROVE BEETLE PALAEOBIOLOGY AT THE NATURAL HISTORY HISTORY MUSEUM OF DENMARK

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Keywords: Coleoptera, Staphylinidae, fossils, taxonomy, phylogenetics

With more than 66,000 described extant and over 400 fossil species the rove beetles (Insecta: Coleoptera: Staphylinidae) are arguably the largest family of all eukaryotic organisms[1]. Rove beetles dominate terrestrial habitats all over the world and have inhabited our planet since at least the Middle Jurassic[2]. They are pervasive in leaf litter and other ground-based habitats and exhibit numerous associations with other organisms; for instance, many are inquilines of ant or termite nests, some have evolved a mutualism with mammals, and some are plant pollinators. Despite rove beetles being an important and significant component of Earth's biodiversity, their evolutionary tree is only known based on fragmentary data. Understanding the evolution of such an old, ecologically, and morphologically diverse animal group should consider both the crown and the stem group diversity. Fossils are the key for understanding the evolution of organismal groups by acting as anchor points in time or providing insights into morphological character evolution. In addition, they are informative about the historical biogeography and environmental conditions that shaped and will continue to shape extant biodiversity. Therefore, the study of rove beetle fossils and their inclusion in phylogenies is paramount. In the Solodovnikov Lab at the Natural History Museum of Denmark (NHMDK), we are conducting diverse research on rove beetle fossils from various deposits. Our studies on rove beetle fossils range from the Jurassic of Karatau through to the mid-Miocene Dominican amber. We primarily conduct taxonomic work, describing new taxa based on their morphology, reinterpreting described fossils, and incorporating fossils in phylogenetic analyses alongside their extant relatives. We collaboratively implement micro-CT and synchrotron scanning to study the detailed morphology of focal taxa. In my poster presentation, I will highlight some results of our research on rove beetle palaeobiology and highlight them as an exemplary group for palaeontological research.

References

1. Newton, A.F. 2022: StaphBase: Staphyliniformia world catalog database (version Aug 2022): Staphylinoidea, Hydrophiloidea, Histeroidea (except Histeridae), in Bánki O. et al. (Eds) Catalogue of Life Checklist (Aug 2022). https://www.catalogueoflife.org/ (accessed 12 February 2022).
2. Chatzimanolis S. 2018: A review of the fossil history of Staphylinoidea. in Betz O. et al. (Eds) Biology of rove beetles (Staphylinidae). Springer International Publishing.

NOTES

WIDESPREAD MINERALIZATION OF INSECTS IN MID-CRETACEOUS KACHIN AMBER

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Key words: fossil resin, diagnesis, calcification, carbonisation, silicification

Amber biological inclusions have generally been interpreted as hollow moulds or mummified remains coated or filled with carbonaceous material. Here, we provide the first report of calcified and silicified insects in amber from the mid-Cretaceous Kachin (Burmese) amber based on multi-technique analyses, including light microscopy, scanning electron microscopy (SEM), energy-dispersive and wavelength-dispersive X-ray spectroscopy (EDX and WDX), X-ray micro-computed tomography (micro-CT) and Raman spectroscopy. We discovered that the labile tissues of Kachin amber inclusions mainly consist of calcite, chalcedony and quartz with minor amounts of carbonaceous material, pyrite, iron oxide and phyllosilicate minerals. The presence of calcite, quartz, and chalcedony as cements filling voids in cracks suggests that these minerals originated from chemical species that entered the fossil inclusions via cracks in the resin. The results demonstrate that resin and amber are not always closed systems. Fluids (e.g. sediment pore water, diagenetic fluid and ground water) at various burial stages, resulting in an impact on the preservational quality and morphological fidelity of amber biological inclusions.

NOTES

FIRST FEMALE OF FOSSIL *BURMOTHAUMA* (EOMEROPIDAE, MECOPTERA) FROM BURMESE AMBER SHEDS LIGHT ON ENVIRONMENTAL PREFERENCES OF FOSSIL EOMEROPID IN THE CRETACEOUS

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Keywords: Eomeropidae, Mecoptera, Burmese amber, palaeoecology

The Eomeopidae is a small family of scorpionflies (Mecoptera) that includes 14 species, of which only one is living today – *Notiothauma reedi* MacLachlan, 1877[1]. The oldest fossil representative of the family is dated to the Early Jurassic[2] (*Jurachorista bashkuevi* Soszyńska-Maj et al., 2016), while the remaining species are known from the Jurassic, Cretaceous to Paleogene[3]. Most species are described as impressions in sedimentary rocks, only one described recently is an inclusion in a fossil resin. The subject of this study is a well-preserved and almost complete female *Burmothauma eureka* Zhang et al., 2022[4] in Burmese amber from the northern Myanmar dating to the early Upper Cretaceous (Cenomanian) from the collection of the Nanjing Institute of Geology and Palaeontology CAS (China). It is a first specimen of a fossil female from the family Eomeropidae whose genitalia can be reconstructed and morphology can be compared with a modern representative of this family. In the same piece of amber, there are syninclusions providing information about the habitat of the studied scorpionfly. Among the syninclusions four Staphylinidae (Coleoptera), three flies from the families Cecidomyiidae and Keroplatidae (Diptera, Nematocera), and a mite from the family Bdellidae were identified.

References

1. MacLachlan R. 1877: Monographic revision and synopsis of the Trichoptera of the European fauna (1874–1880). John van Voorst.
2. Soszyńska-Maj A. et al. 2016: J. Syst. Palaeontol., 14, 1025–1031; doi:10.1080/14772019.2016.1139007
3. Zhao X.D. et al. 2019: Proc. Geol. Ass., 130, 691–695; doi:10.1016/j.pgeola.2019.10.005
4. Zhang K. et al. 2022: Cretac. Res., 133, 105140; doi:10.1016/j.cretres.2022.105140

NOTES

NEW ZEALAND AMBER: AGE, DEPOSITIONAL SETTING AND BIOINCLUSIONS

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Keywords: Gondwana, amber, Cretaceous, Cenozoic, arthropods

Amber (fossilised tree resin) is relatively common in sedimentary sequences on the long-isolated former Gondwana landmass of New Zealand. On both North Island and South Island amber is found in a variety of depositional settings, from *in situ* amber attached to tree stumps in fossil forests, to variably transported (reworked) amber in estuarine, fluvial or palustrine settings to isolated lumps of amber in marine sediments of the continental shelf. Pollen analyses of the amber-bearing sediments, and biostratigraphic and radiometric age data of under and/or overlying strata, where available, indicate that the age of the different New Zealand amber localities ranges between Cretaceous and Pliocene. Mid/Upper Eocene and lower Miocene ambers are particularly common, whereas amber from the Paleocene, lower Eocene, and mid/upper Miocene are rare. The oldest ambers currently known from New Zealand are from the Tupuangi Formation (Cenomanian) on Chatham Islands[1] and the Horse Range Formation (Campanian) in Otago, South Island. New Zealand amber was traditionally believed to be free of biological inclusions but our systematic search has revealed a range of invertebrates, plant remains and fungi in Oligocene and Miocene ambers from Otago and Southland, South Island[2]. These include a range of terrestrial arthropods such as Pseudoscorpiones, Acari, Araneae, Collembola and insects from the orders Hemiptera, Psocoptera, Hymenoptera, Coleoptera, Lepidoptera and Diptera, together with other soft-bodied organisms that are rarely preserved in other sedimentary settings. Our ongoing study of New Zealand amber is yielding examples from further groups of invertebrates from new and previously known sites, including the first arthropod inclusions from Eocene amber. Together these finds provide extremely rare data concerning the past diversity and ecological complexity of New Zealand's ancient amber forests, and they may help to decipher how the unique New Zealand biota has changed over time. Here, we provide an up-to-date overview of the occurrence of amber in New Zealand, its age and depositional environments, with emphasis on fossiliferous amber deposits. We summarize the main invertebrate groups currently known from New Zealand amber and highlight some issues concerning the preservation and preparation of New Zealand amber inclusions.

References

1. Mays C. et al. 2017: Geology, 45, 1119–1122; doi:10.1130/G39453.1
2. Schmidt A.R. et al. 2018: Gondwana Res., 56, 135–146; doi:10.1016/j.gr.2017.12.003

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DEMATIACEOUS MICROFUNGI FROM EUROPEAN PALAEOGENE AMBERS

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Keywords: Ascomycota, Baltic amber, fungi, sooty moulds

Fungi are one of the most diverse groups of organisms[1], but their fossil record is scarce compared with that of plants and animals. However, many fossils of microfungi are preserved as inclusions in amber, and some of these fossils were already discovered and described during the 19th century. We have studied and reassessed the systematic affinities of microfungi described by Robert Caspary and Richard Klebs over a century ago[2,3]. In addition to historical collections, several new kinds of fungi have been found from more recently discovered amber specimens from Baltic (Eocene) and Bitterfeld (Oligocene) ambers. These include the first fossils of lichen-associated filamentous fungi[4,5]. All the fossil fungi studied grew either on or in the immediate vicinity of resin-producing trees, which made them likely candidates for preservation in amber. Our findings show that European Palaeogene amber forests housed diverse communities of microfungi that represented several morphologies and ecological strategies. Even though relatively few fossil microfungi in amber can be identified accurately enough to be used as minimum age constraints in dating phylogenetic trees of different fungal lineages, fossil microfungi provide valuable information on ancient microbial life and thus help completing pictures of ancient ecosystems.

References

1. Blackwell M. 2011: Am. J. Bot., 98, 426–438; doi:0.3732/ajb.1000298
2. Kettunen E. et al. 2015: Rev. Palaeobot. Palynol., 219, 183–193; doi:10.1016/j.revpalbo.2015.03.010
3. Kettunen E. et al. 2019: Pap. Palaeontol., 5, 365–389; doi:10.1002/spp2.1238
4. Kettunen E. et al. 2016: New Phytol., 209, 896–898.
5. Kettunen E. et al. 2016: Earth Environ. Sci. Trans. R. Soc. Edinb., 107 (2-3), 311–320; doi:10.1017/S1755691017000111

NOTES

A BRIEF REVIEW OF KNOWN AMBER PAUSSINAE (COLEOPTERA: CARABIDAE) AND THE IMPORTANCE OF THE FIRST ROVNO AMBER PAUSSINE FINDING

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Keywords: climate, Eocene, *Eohomopterus,* Neotropics*,* transarctic migrations

The subfamily Paussinae is a myrmecophilous group within the Carabidae (Coleoptera) and is divided into five tribes: Metriini, Ozaenini, Protopaussini, Paussini and Kryzhanovskianini[1,2]. Extant paussines include around 870 species.

Currently, Paussinae has 26 extinct species belonging to ten genera in three tribes described from the Cretaceous to the Neogene in different ambers (Fig. 1A). The oldest paussine *Kryzhanovskiana* Kataev & Kirejtshuk, 2019 (originally classified as Metriini, reclassified as Kryzhanovskianini by Deuve 2020) was described from the earliest Cenomanian Kachin amber. The largest number of fossil paussines (20 species that strongly needs revision) are known from Baltic amber and placed in six extinct genera: *Arthropterites* Wasmann, 1925, *Cerapterites* Wasmann, 1925, *Eopaussus* Wasmann, 1926, *Pleurarthropterus* Wasmann, 1927, *Protocerapterus* Wasmann, 1926 and *Succinarthropterus* Kolbe, 1926[3].They probably belong to the subtribe Carabidomemnina Wasmann, 1928 of the tribe Paussini[4]. Neotropical extinct paussines (three species from three extant genera) are described from Miocene Dominican and Mexican ambers: *Protopaussus* Gestro, 1892 in the Protopaussini, *Eohomopterus* Wasmann, 1925 and *Homopterus* Westwood, 1841, both in the Paussini.

The first Rovno amber specimen was available for study. Based on its morphology it belongs to a “defiant” species and has no stridulatory organs, and it shows great similarity to the genus *Eohomopterus*.

The presence of structures associated with myrmecophily in fossil beetles, such as trichomes, crassate antennae, cephalic horn, or lack of tactile setae, suggest that myrmecophily in paussines existed already in the early Paleogene[4]. It is likely that Paussini and Protopaussini’s myrmecophily has a single evolutionary origin.

The extant Paussines are found mostly in the subtropics and tropics (Fig. 1B). In a greenhouse Eocene climate, their distribution was much broader. Probably their extant distribution is associated with their cryophobicity and ability to transarctic migrations[5]. Extant *Eohomopterus* are distributed exclusively in regions with a macrothermal climate. So the Rovno paussine discovery shows that the climates of the Rovno and Baltic amber forests were similar. Whether climate change is the main reason for the reduction in paussine ranges or not remains a debatable issue.

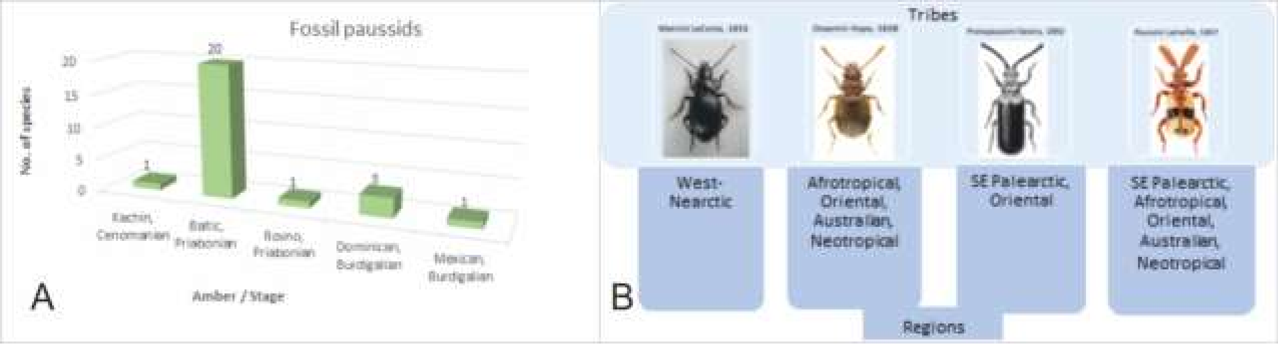

Fig. 1. A. Number of fossil paussines in different ambers. B. The distribution of extant representatives of the tribes of Paussinae.

References

1. Di Giulio A. et al. 2003: Syst. Entomol., 28(4), 509–537; doi:10.1046/j.1365-3113.2003.00227.x
2. Deuve T. 2020: Bull. Soc. entomol. Fr., 125(2), 199–205; doi:10.32475/bsef_2138
3. Nagel P. 1987: Entomol. Arb. Mus. G. Frey Tutzing bei Münch., 35/36, 137–170.
4. Geiselhardt S.F. et al. 2007: Sci. Nat. 94, 871–894; doi:10.1007/s00114-007-0271-x
5. Archibald S.B. et al. 2023: Can. Entomol., 155, e6; doi:10.4039/tce.2022.49

NOTES

THE IMPORTANCE OF ACCURATE IDENTIFICATION OF FOSSIL RESINS

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Keywords: material identification, gemmological methods, material authenticity, spectroscopy, FTIR

The review outlines the methods used by Amber Experts Laboratory for material identification, including amber, fossil resins, subfossil resins, and synthetic imitations. It is important to confirm the authenticity of the resin before proceeding with the analysis and identification of inclusions. It is crucial to determine the presence or absence of human interference in the studied specimen.

Accurate identification requires specialized knowledge, experience, and a wide library of reference samples. Frequently used methods to study raw and polished pieces are gemological, microscopic, and spectroscopic. Gemological methods rely on observing the physical characteristics of the resins, such as magnification, UV-Vis, and polarized light observation. Instrumental methods mainly include FTIR spectroscopy, which analyzes spectra and compares them with a reference library of spectra.

Confirming the authenticity of the material and ruling out human interference is an important stage in the research process. Basic sample preparation for analysis and identification of inclusions involves cutting, grinding, and polishing to best visualize the inclusion. Inclusion researchers need to know if the sample has undergone any modification processes in addition to sample preparation.

It happens that people deliberately introduce inclusions into fossilized resins to increase their market value, which further complicates the process of identification and interpretation. Such practices are detected during testing at Amber Experts Laboratory.

Many people try to conduct material tests themselves, but it is important to remember that some typical tests are destructive and can damage the resin structure irreversibly. To ensure the reliability and accuracy of research results, it is recommended to use the services of specialized laboratories that use non-destructive resin testing methods. Amber and other resins are highly delicate research materials, and tests are performed with care for inclusions and the preservation of resin specimen integrity. Collaboration with palaeoentomologists and establishing a method of preparing the specimen for examination is crucial.

NOTES

FIRST *CHILELIMNOPHILA* (DIPTERA: LIMONIIDAE) IN FOSSIL RECORD

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Keywords: Spanish amber, Kachin amber, Cretaceous, distribution

First evidence of the occurrence of the genus *Chilelimnophila* (Diptera: Limoniidae) in the ancient epochs of the history of the Earth is reported from the fossil record. Cretaceous resins as Spanish amber and amber from Kachin document the occurrence of *Chilelimnophila* just in the Cretaceous. To this day only one species belonging to the *Chilelimnophila* have been known from modern fauna – *Chilelimnophila lyra*. The conducted research of new materials, preserved as an inclusions in Spanish amber, allowed to shift the stratigraphic range to ca. 105 Ma, to the upper Albian (Early Cretaceous). Thanks to conducted analyses it was possible to describe three new species preserved as inclusions in Spanish amber and in Kachin amber. It is also worth underlining that the recent species *Chilelimnophila lyra* has a restricted geographical distribution, it was found in Chile, in the area from the northernmost limit at the Cordillera de Nahuelbuta to the southernmost limit at Chiloé Island within the Subantarctic Biogeographical Province in South America. Conditions of the formation of Spanish amber deposits and amber resin from Kachin in the Cretaceous period were quite different from those, where the recent species of the genus do occur. The new information obtained is of particular importance for understanding the evolution of this group of insects, in relation to the environment of their occurrence.

NOTES

UNIQUENESS OF PRESERVATION OF FOSSIL MATERIAL FROM FUR FORMATION ON THE EXAMPLE OF *ARCTOCONOPA* (DIPTERA, LIMONIIDAE)

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Keywords: Fur Formation, Paleocene-Eocene, Limoniidae, imprint

The Danish Fur Formation site in Jutland was deposited *ca*. 55 Ma just above the Paleocene-Eocene boundary. The age is similar to the Oise amber from France and documents the Paleocene-Eocene Thermal Maximum with tropical or sub-tropical flora and fauna. Fur Formation is known for its abundant fossils and the quality of preserved imprints in sedimentary rocks due to its volcanic origin. The fossil specimens have been preserved in very good condition, with not only morphological structures but also color patterns on the wings perfectly visible. The quality of these materials can be compared with the well-known Daohugou locality in China, dating to the Late Jurassic. In China only large specimens (e.g. Mecoptera) are well-preserved and small flies are in poor condition. In contrast, small insect specimens with good preservation can be found at the Fur Formation. As for the specimens of the genus *Arctoconopa* (Chioneinae, Limoniidae). This latter is a group of insects with wings about 6 mm length and they were all from the Holarctic. At the Fur Formation outcrop, two specimens of *Arctoconopa* sp. with exceptional color patterns preservation on the wings were found. Noteworthy that other families (like Tipulidae and Cylindrotomidae) found on this same site have this color preservation. This character is used for species identification. The talk presents an overview of the fantastically preserved nematocerous material found in the studied collections from the Fur Formation on Fur and Morse Islands.

NOTES

FIRST CLICK-BEETLE LARVAE FROM THE MID-CRETACEOUS AMBER OF NORTHERN MYANMAR

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Keywords: Elateridae, fossils, Gondwana, Mesozoic, Parablacinae

Elateridae (click-beetles) are the most species-rich beetle family in Elateroidea, including more than 10,000 described species from all major zoogeographical regions. The classification of this group is in a state of flux and its monophyly and limits remain contentious[1]. The origin of Elateridae remains uncertain; however, they were abundant already in the Jurassic period[2]. The fossil record of Elateridae includes over 250 species in approximately 100 genera[2]. The Jurassic click-beetle fauna consisted of more than 100 described species. However, only about 30 species were described from the Cretaceous period, most of them being compression fossils. Recently, there is an increasing number of studies dealing with fossils from Cretaceous ambers. For example, in 2022, the first click-beetle was described from amber of the Upper Cretaceous Ajka Coal Formation in Hungary (ajkaite)[3]. Most popular is the mid-Cretaceous amber of northern Myanmar (Burmese amber), which, during the past years, has become one of the most important sources of fossil insects. Although Elateridae are comparatively abundant in Burmese amber, only six species have been described from there to date.

In this contribution, we report the first known click-beetle larvae from the Mesozoic Era based on two relatively well-preserved inclusions in Burmese amber. These larvae undisputably belong to the same genus and most probably even to the same species. They are dorsoventrally flattened, with head and prothorax apparently more sclerotized than metathorax and abdomen, nasale tridentate, produced and wider than long, adnasalia approximate, frons lyre-shaped, with posterior part abruptly narrowed and tapered at apical two thirds, epicranial stem short, stipites contiguous at base, mandible unidentate, with small retinaculum mesally, legs with spine-like setae, and abdominal segment IX with long bifurcated urogomphi and spine-like setose tubercles. Morphologically, the studied fossil larvae are similar to those of extant South American *Tibionema* Solier, 1851 and Australasian/South American Parablacinae[4]. They support a relatively recent hypothesis that fauna of the Burmese amber, which may have been on an island at the time of deposition, was at least partly Gondwanan in origin[5].

References

1. Douglas H. et al. 2021: Biology, 10, 451; doi:10.3390/biology10060451
2. Kundrata R. et al. 2021: Insects, 12, 286; doi:10.3390/insects12040286
3. Szabó et al. 2022: Sci. Rep., 12, 24; doi:10.1038/s41598-021-03573-5

4. Kundrata R. et al. 2016: Austral. Entomol., 55, 291–302; doi:10.1111/aen.12185

5. Westerweel J. et al. 2019: Nat. Geosci., 12, 863–868; doi:10.1038/s41561-019-0443-2

NOTES

TERRESTRIAL PARASITENGONA MITES (ARACHNIDA: ACARIFORMES) IN FOSSIL RESINS – STATE OF THE ART

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Keywords: Burmese and Baltic amber, fossil Parasitengona mites, host-parasite relationships

The Parasitengona cohort, with about 11,000 nominal species, is one of the most diverse groups of acariform mites. Parasitengona representatives are aggregated in two ecologically distinct groups, of those Hydrachnidia, known also as water mites (> 6,000 species) are considered monophyletic, whereas the terrestrial Parasitengona (< 5,000 species), most likely paraphyletic ones, suffer from an unresolved picture of relationships. One of the main obstacles in building views on the evolution and phylogeny of parasitengones is the heteromorphism of life instars, resulting in the independent description of larval and post-larval stages: larvae parasitize arthropods (except Trombiculidae *s.l.*, associated with vertebrates), whereas active post-larval stages lead a predatory lifestyle. The correct linkage of names of present-day taxa can be completed by laboratory rearing or by matching DNA sequences obtained from representatives of various instars. Both, however, have relatively low success rates. The situation is also aggravated by the deficit of data on fossil records, partly explained by the specificity of the habitats occupied by these mites.

Neither Hydrachnidia nor the members of vertebrate-associated terrestrial Parasitengona, accounting together for more than 9,000 extant species, have been known as fossils. Other groups (< 2,000 extant species), aggregated in 17 families, are characterized by a greater consistency of the lifestyle, however, the knowledge about their fossil records is still mosaic, and especially the earliest records, published by Koch and Berendt[1] should be critically reappraised.

The purpose of this study is to summarize the existing fossil records on terrestrial Parasitengona (*excl.* Trombiculidae *s.l.*), juxtaposed with the extant representation of 17 family-level taxa.

Throughout the 19th and 20th c., 25 findings of fossil Parasitengona have been published. Of those – 21 pertained to the description of new species among which only one seems unquestionable at present. Over the last two decades, there has been a clear intensification of research on inclusions from the Parasitengona group, which resulted in 32 records, including the description of 16 species new to the science. Representatives of nine out of 17 families of terrestrial Parasitengona mites have been reported in amber inclusions until the present. Most records originate from Cretaceous, and/or Paleogene deposits[2 and references therein,3].

The observed underrepresentation of taxa may be only partly explained by the association of some groups with specific microhabitats, with a limited probability of embedding specimens in resin. Moreover, a particular paucity of data concerns the fossil records of relationships between parasitic larvae and their hosts, e.g.[4]. Thus, despite the intensification of research, there are still gaps that need to be filled in the further quest for fossil evidence, with special reference to underrepresented families.

References

1. Dunlop J.A. et al. 2020: A summary list of fossil spiders and their relatives. In World Spider Catalog. Nat. Hist. Mus. Bern, online at http://wsc.nmbe.ch, version 20.5, accessed on 23 April 2023.
2. Sidorchuk E.A. et al. 2019: Zootaxa, 4647, 44–53; doi:10.11646/zootaxa.4647.1.6
3. Żmudziński M. 2022: Zoosymposia, 22, 224, in Zhang Z.-Q. et al. (Eds) Acarological Frontiers: Proc. XVI Int. Congr. of Acarology. Magnolia Press; doi:10.11646/zoosymposia.22.1.1
4. Arillo A. et al. 2018: Cretac. Res., 86, 24–32; doi: 10.1016/j.cretres.2018.02.006

NOTES

WHERE TRADITIONAL EXTINCTION ESTIMATES FALL FLAT: USING NOVEL COPHYLOGENETIC METHODS TO ESTIMATE EXTINCTION RISK IN PATHOGENS

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Keywords: host switching, extinction, helminths, cophylogeny, symbionts

Today parasites comprise a huge proportion of living biodiversity and play a major role in shaping community structure. Given their ecological significance, parasite extinctions could result in massive cascading effects across ecosystems[1]. Whether they go extinct with their hosts through coextinction events or survive through subsequent host-switching events has important implications for their surrounding communities. It is therefore crucial that we have a way of estimating their extinction risk. Attempts to do this have often relied on information about host extinction risk, without explicitly incorporating information about the parasites. However, assuming an identical risk may be misleading. In our study[2], we apply a novel metric to estimate the cophylogenetic extinction risk, *Ec*, of parasites with their hosts. This metric incorporates information about the evolutionary history of symbionts and hosts (host switching, symbiont extinction, symbiont duplication, cospeciation) that can be estimated using event-based cophylogenetic methods[3]. To explore this metric, we investigated the use of different cophylogenetic methods to inform the *Ec* risk, based on the analysis of flatworm parasites and their anuran hosts[4]. We show using both parsimony- and model-based approaches that different methods can have a large effect on extinction risk estimation (e.g., extinction risk is lower in the model-based DTL approach implemented in ALE[5] than the traditionally used parsimony-approach). For example, lower estimates of parasite extinction risk are associated with higher estimates of host switching. Further, we demonstrate that model-based approaches offer greater potential to provide insights into cophylogenetic history and extinction risk. Simulations revealed that cospeciation has occurred more frequently than expected by chance, suggesting an evolutionary tendency towards cospeciation within the group. This method would have great potential to study nematode-arthropod or other symbiont-arthropod interactions commonly preserved in amber where both partners have well-resolved phylogenies.

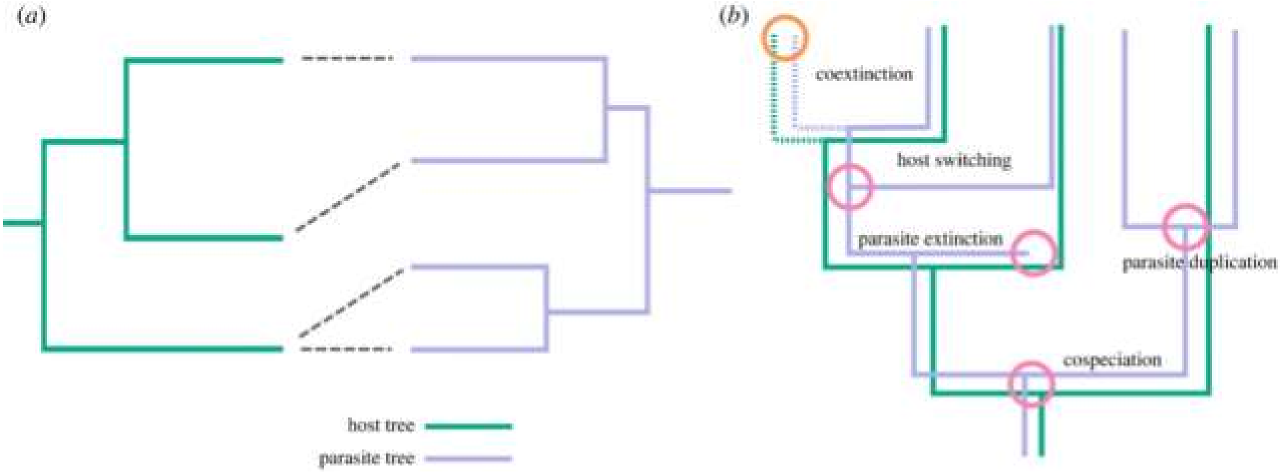

Fig. 1. Example of a host–parasite association. (*a*) Illustration of extant relationships. (*b*) Pink circles show the four common evolutionary events estimated using co-phylogenetic methods (cospeciation, host switching, parasite extinction and parasite duplication), and the orange circle shows coextinction, which cannot be inferred using cophylogenetic methods directly.

References

1. van Dijk J., De Baets K. 2021: Biodiversity and host-parasite (co)extinction, in De Baets K., Huntley J. (Eds) The evolution and fossil record of parasitism: coevolution and paleoparasitological techniques. Topics in Geobiology 50. Springer; doi:10.1007/978-3-030-52233-9_3
2. Mulvey L. et al. 2022: Proc. Royal Soc. B, 289, 20220432; doi: 10.1098/rspb.2022.0432
3. Doña J., Johnson K.P. 2020: Biol. Conserv., 250, 108705; doi:10.1016/j.biocon.2020.108705
4. Badets M. et al. 2011: Syst. Biol., 60, 762–781; doi:10.1093/sysbio/syr078
5. Satler J. D. et al. 2019: Evolution, 73, 2295–2311; doi: https://doi.org/10.1111/evo.13809

THE COMPARISON OF APHIDS FROM CANADIAN AMBER TO FAUNAS FROM OTHER FOSSIL RESINS

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Keywords: Canadian amber, fossil aphids, apterous morph, Canadaphididae, Late Cretaceous

The Late Cretaceous has yielded abundant deposits with fossil resins rich in animal remains. In some ambers aphids dominate in terms of abundance and diversity. Such resins are represented by Canadian amber, which is a popular term referring to fossil resins from the Campanian Grassy Lake in Alberta and secondary deposits from Cedar Lake in Manitoba[1].

Untill the Late Jurassic aphids are extremely rare in fossil materials. A richer fauna of aphids begins to occur in sediments and fossil resins from the Cretaceous.

Aphid-characteristic features include a complex life cycle involving heterogyny and the occurrence of alate and apterous forms which reproduce sexually or parthenogenetically.

Due to taphonomic processes, apterous morphs hardly could be preserved in the form of imprints on sedimentary rocks. For inclusions in fossil resins, the situation is different, but even in such materials apterous morphs are not reported from very old periods. The oldest apterous morph comes from the Early Cretaceous Lebanese amber, and it is a single oviparous female and a larva belonging to the family Thelaxidae[2]. Another adult apterous specimen has been found in Santonian Taimyr amber. It is a single inclusion assigned to the family Eriosomatidae[3]. More abundant apterous morphs are described from a slightly younger Campanian Canadian amber. The forms include both larvae and adult females which have been assigned to 8 species in 5 genera of the families Mesozoicaphididae and Cretamyzidae[4]. Additionally, a larva of an uncertain taxonomic position has been recorded[5]. The materials which are being examined at the moment contain several specimens representing new species including the first apterous morph of the family Canadaphididae, the species *Canadaphis carpenteri*. A fluorescence microscope was used for the first time to reveal more morphological details such as a family-typical structure of elongated apex of abdomen and cauda.

Unlike older faunas, in Canadian amber apterous aphid morphs occur in abundance. This may suggest that changes in the life cycle were in progress at that time and the insects started using herbaceous plants as secondary hosts. Consequently, apterous morphs began to co-occur with the alate ones. The changes in aphid biology were probably connected with advancing cooling of the climate.

Thus, adapting to the climate with cooler seasons might have resulted in subsequent evolutionary successes of the group in the Cenozoic.

References

1. McKellar R. C., Wolfe A. P. 2010: Canadian amber, in Penney D. (Ed.) Biodiversity of fossils in amber from the major World deposits. Siri Scientific Press.

2. Wegierek P., Grimaldi D.A. 2010: Acta Geol. Sin.-Engl., 84 (4), 665–672; doi:10.1111/j.1755-6724.2010.00243.x

3. Ogłaza B. et al. (in prep.)

4. Heie O.E., Pike E.M. 1992: Can. Entomol., 124 (6), 1027–1053; doi:10.4039/Ent1241027-6

5. Heie O.E. 2006: Insect Syst. Evol., 37, 91–104; doi:10.1163/187631206788831560

NOTES

NEW INSIGHT INTO BIOGEOGRAPHICAL HISTORY OF THE GENUS *ROBSONOMYIA* (DIPTERA: KEROPLATIDAE) – FIRST EUROPEAN AND FOSSIL SPECIES

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Keywords: Diptera, Keroplatidae, *Robsonomyia*, biogeography, amber

The Diptera family Keroplatidae is one of the largest families of the infraorder Bibionomorpha with nearly 1,000 extant living species and 53 fossil ones described[1]. In the fossil record, they are known from as early as the Lower Cretaceous (sedimentary rocks of England, Durlston Bay)[2]. In later geological periods, they appear in various types of fossil resins and sedimentary rocks; however, the largest number of species has been found in Baltic amber (dated to the middle period of the Eocene)[1,3]. Until now, 18 species belonging to nine genera have been described from this amber. Now, an additional species has been discovered.

The new species is particularly interesting since it is the first fossil representative of the genus *Robsonomyia* Matile et Vockeroth. Furthermore, this is the first species of that genus found at the European continent. Until now, this taxon has been characterised by a disjunct range of occurrence and has been represented by only two modern species. One known from North America (USA, Canada) – *R. reducta* Matile et Vockeroth, 1980, and the other known from Asia (Japan) – *R. sciaraeiformis* (Okada, 1939)[1].

This fossil species gives us a new insight into the biogeographical history of *Robsonomyia* and provides evidence that this genus was widely distributed throughout the Holoarctic region. This creates questions like what caused the disappearance of these taxa on the European continent? and how these flies overcame the geographical barrier separating the North American continent from Asia? A similar, disjunctive pattern of occurrence is widely observed among other groups of organisms, but there is no universal answer that can explain this phenomenon in all of them (for example, Beringia's connection during the Pleistocene existed on the high latitude 69°N, which prevented thermophilic species from dispersing by this route and may also have made it difficult for the flies to expand their ranges this pathway[4]). Therefore, it was necessary to analyse the pattern of occurrence of this genus individually.

References

1. Evenhuis N.L. 2006: Bishop Mus. Bull. Entomol., 13, 1–178.
2. Jarzembowski E.A., Coram R. 1997: Proc. DNHAS, 118, 119–124.
3. Grimaldi D.A., Ross A.J. 2017: Extraordinary Lagerstätten in amber, with particular reference to the Cretaceous of Burma, in Fraser N.C., Sues H.-D. (Eds.) Terrestrial conservation Lagerstätten. Windows into the evolution of life on land. Dunedin Academic Press Ltd.
4. Wen J. 1999: Annu. Rev. Ecol. Evol. Syst., 30 (1), 421–455.

NOTES

INCLUSIONS IN AMBER FROM COLLECTIONS OF THE POLISH ACADEMY OF SCIENCES MUSEUM OF THE EARTH IN WARSAW

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The Amber Department came into being at Warsaw's Museum of the Earth in 1951. The amber collection is currently divided into the following categories: faunal inclusions; plant inclusions; natural forms; varieties of Baltic amber; a regional collection of succinite and other fossil resins; imitations; archaeological to contemporary artefacts[1]. Most of the twenty thousand amber pieces with inclusions have been taxonomically determined by specialists from Poland and abroad. A list of taxa contained in the faunal inclusions collection was published, among others in 1993[1]. The *List of the* [108] *holotypes in the collections of the organic inclusions of the Museum of the Earth, Warsaw* was published, with references to holotypes, in 2001[2]. The current list of holotypes is being prepared for printing and will be presented during the Conference. PAS Museum of the Earth's in Warsaw collection database is being built. Information about the amber collection can be obtained from Katarzyna Kwiatkowska, head of the Amber Department. A monographic report on the largest of the Museum's individually compiled collections (by Tadeusz Giecewicz, numbering over 8000 thin sections prepared for analysis) was published together with catalogue[3]. The following specimens are among the rarest in the faunal inclusions collection: Crustacea[4], Embioptera, Mecoptera, Diptera: Trichoceridae, Strepsiptera. Evidence of mammals comes in the form of six specimens containing animal hair and about dozen specimens with autopodial mammalian imprints on nodules of Baltic and Saxonian amber (three of them described as ichnotypes – one Insectivora, family Chrysochloridae; and two Hyracoidea from family Procaviidae[5]).

References

1. Kulicka R. 1993: Ann. Upper Silesian Mus. in Bytom, Nat. Hist., 13, 49–56.
2. Kosmowska-Ceranowicz B., Pielińska A. 2001: in Kosmowska-Ceranowicz B. et al. 2001: Acta Acad. Artium Vilnensis, 22, 61–63.
3. Kupryjanowicz J. 2001: Mus. of the Earth. Doc. Stud., 18, 19–72.
4. Jażdżewski K., Kulicka R. 2002: Acta Geol. Polonica, 52, 3, 37–383.
5. Kulicka R., Sikorska-Piwowska Z. 1999: in Kosmowska-Ceranowicz B., Paner H. 1999: Investigations into amber, 83–87.

NOTES

THE REMARKABLE PALAEODIVERSITY IN BURMESE (MYANMAR) AMBER (MID-CRETACEOUS) – UPDATED

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Keywords: palaeobiodiversity, faunistic list, fossil resin

In 2019, at the 8th International Conference on Fossil Insects, Arthropods & Amber in the Dominican Republic, I reported on the dramatic rise in the number of species described in Burmese amber from Myanmar. In 1999 there were only 45 species known though by the end of 2018 there were 1,192 species known.

The rate in the number of species being described each year has remained high even though we have been through a pandemic and the ethics of Burmese amber has come under scrutiny after the reports of atrocities in Myanmar. A number of 368 new species were named in 2022, the highest for any year, and by the end of that year the total had reached 2,524 species.

Traditionally all the amber came from Kachin State and is believed to be of late Albian/early Cenomanian age, however, the discovery of amber in Tilin and Hkamti of different ages adds uncertainty to the fossil record if the provenance of pieces is not known or not accurately recorded.

NOTES

"OUR GRAVES HAVE MORE LIFE": FOSSIL TIPULOMORPHA FROM THE CRATO FORMATION OF NE BRAZIL

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The Crato Formation is a Konservat-Lagerstätte from the Cretaceous. This Formation is located in Northeast Brazil and is a source of specimens of the Aptian/Albian boundary. Although this Formation also remains in evidence throughout time, recently new studies reinterpreted the palaeoenvironment[1] and taphonomy[2] of Crato. Before, Crato was imagined as a large hypersaline inland lake, but now the more plausible scenario is a vast wetland of complex environments, from salt pans to lagoons. The current approach altered the previous hypotheses about biodiversity constitution and trophic web and highlighted the diverse and abundant entomofauna of the region.

With a different sight, more funding initiatives, and a multi-institutional focus, the entomofauna of Crato was revisited. New collects aimed at arthropods revealed an astonishing number of lineages. The core of these diversity discoveries is still in Neuroptera and Odonata, but many new Diptera were found. Some of these Diptera lineages have deep phylogenetic relevance. The most powerful evidence is present in Tipulomorpha, noteworthy, the genus *Leptotarsus*. This genus is still speciose nowadays, only in Brazil lived 41 of the 344 valid species. In Crato, gathering material from new collects and many institutions, 21 species were described in the last decade. These species are variable, with some almost twice in length than the others[3].

This diversity level also exists in other insect genera, such as *Blittersdorffia* (Neuroptera). Although there are some questions if *Leptotarsus* is a monophyletic genus or a stem group of the other Tipulidae, the multiplicity of environments may facilitate niche diversification even into genera. It is not uncommon for craneflies to collect numerous species from the same genera in the same place or trap[4]. These studies also reinforce the importance of projects aimed at analyzing this diversity.

Crato Formation is also a place of other interesting lineages of Tipulomorpha, such as *Okrenomyia* and *Cratotipula*. The lack of phylogenetic positioning blurs the broad framework of the evolution of these lineages. More than numerous findings, it is necessary to put all this information in an evolutionary context. Tipulomorpha peak of diversity also is a reflex of a new look for this diverse Formation. With more studies, the entomofauna may be a sight in perspective and bring up the enormous potential for further understanding of the life and evolution of these groups.

References

1. Ribeiro A.C. et al. 2021: Earth Sci. Rev., 216; doi:10.1016/j.earscirev.2021.103573

2. Dias J.J. et al. 2022: Cretac. Res., 130, 105068; doi:10.1016/j.cretres.2021.105068

3. Santos D. et al. 2023: Cretac. Res., 142, 105372; doi:10.1016/j.cretres.2022.105372

4. Amorim D.S. et al. 2022: Sci. Rep., 12, 1734; doi:10.1038/s41598-022-05677-y

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A NEW GROUP OF AMBER SOURCE PLANTS FROM THE CRETACEOUS

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Keywords: amber, Araucariaceae, Cheirolepidaceae, Erdtmanithecales, Eucommiidites, *in situ* pollen

Amber deposits, often large and with significant inclusions, are fairly common in the Early to mid Cretaceous. Where analyses of the Early Cretaceous ambers are available, many of these ambers are thought to derive from one of two conifer plant sources: either the Araucariaceae and the (now extinct) Cheirolepidiaceae. Sometimes it is not clear which of these conifer families is the source as both may be present in the deposit and their amber chemistry appears indistinguishable.

Amber has been reported from the Early Cretaceous Crato Formation, as isolated clasts or within plant tissues. Previously undescribed cones have also been recovered with amber preserved *in situ*. Here, we focus on these highly morphologically unusual cones with amber inside their tissues and use different approaches to understand their botanical affinity. This means that we can also understand the fuller diversity of amber-source plants present in the Crato Formation and potentially elsewhere.

We described a new taxon of amber-bearing pollen cone, from more complete and from disarticulated specimens. The best-preserved cones are where the amber-filled resin canals are found inside the preserved microsporophyll tissues. We identified the pollen as of the *Eucommiidites*-type.

This pollen type, together with the in situ amber, is now clear evidence of a new amber source plant that has not been previously recognised and, importantly, is not a conifer. The *Eucommiidites*-type pollen discovered places this genus within the Erdtmanithecales, an incompletely known gymnosperm group from the Mesozoic that are not related to the conifers (such as the Araucariaceae and Cheirolepidiaceae). This is a completely unexpected result and represents a whole new group of plants that were resinous in the Cretaceous.

We also performed chemical analyses on the in situ amber. FTIR analysis of the in situ amber indicates a potential araucariacean conifer affinity, although affinity with cupressacean conifers cannot be definitely ruled out. Using Pyr-GC-MS analysis of the in situ fossil resin shows that it is a mature class Ib amber, thought to indicate affinities with araucariacean and cupressacean, but not pinaceous, conifers[1]. This is the first confirmed occurrence of this class of amber in the Crato Formation flora and in South America, except for an archaeological sample from Laguna Guatavita, Colombia. What does this mean for us when analysing amber chemistry?

The combined results of the cones' novel gross morphology and the analyses of the in situ amber and pollen shows that there was a previously unknown resinous erdtmanithecalean gymnosperm present in the Crato Formation. These results show that the diversity of potential amber source plants from the Crato Formation is now expanded beyond the Araucariaceae and the Cheirolepidiaceae to include this member of the Erdtmanithecales. Importantly, *Eucommidites* pollen does occur in different amber localities during the early Cretaceous and as the amber chemistry is identical to that of araucarian and cheirolepidiacean plants, it should now also be considered as a potential amber source plant wherever the pollen is found.

References

1. Seyfullah L.J. et al. 2020. BMC Evol. Biol., 20, 107; doi:10.1186/s12862-020-01651-2

NOTES

GLITTER IN AMBER – LONG-LEGGED FLIES (DOLICHOPODIDAE) IN BALTIC AMBER

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Keywords: long-legged flies, Dolichopodidae, Baltic amber, Empidoidea

Dolichopodidae (long-legged flies) is cosmopolitan and one of the largest Diptera families, placed within superfamily Empidoidea, with more than 7200 species included. Long-legged flies are often eye-catching metallic green, bronze, or blue bodies. Dolichopodidae *sensu lato* includes 21 subfamilies with Microphorinae and Parathalassiinae, in opposite to Dolichopodidae *sensu stricto* that includes 19 subfamilies[1]. The affiliations of some Dolichopodidae genera are still uncertain. However, in the traditional view, the concept of the family Dolichopodidae refers to the Dolichopodidae *sensu* stricto. In the paleobiological studies, they are considered as Dolichopodidae *sensu lato*. The family is known since the Lower Cretaceous and the oldest representative of the family is *Sympycnites primaevus* Grimaldi et Cumming[2], described from the Lebanese amber (125–135 Ma).

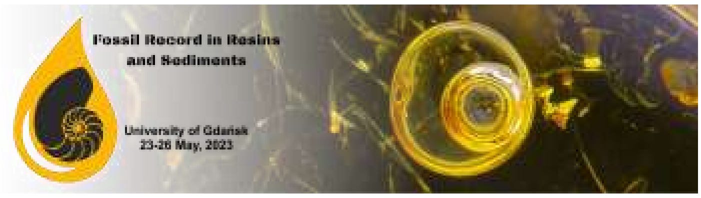
Long-legged flies are well represented in the fossil record, especially in fossil resins due to their behaviour. Adults of long-legged flies live on tree trunks (hunting for prey and serching for mate) becoming easily entrapped in sticky resin.

There are 72 species within 24 genera of fossil Dolichopodidae described from the Baltic amber[4,5]. Most of the Eocene species were described in recent species-rich genera, such as *Dolichopus* (10 species), *Argyra* (7 species), and *Palaeomedeterus* (7 species). However, several recent taxonomic works[4,5] demonstrate the need to revise old descriptions from the beginning of the 20th century made by Meunier.

References

1. Wahlberg E., Johanson K.A. 2018: Syst. Entomol., 43 (4), 619-636; doi:10.1111/syen.12297
2. Grimaldi D.A., Cumming J. 1999: Bull. Am. Mus. Nat. Hist. 239, 1–124.
3. Evenhuis N.L. 1994: Catalogue of the fossil flies of the world (Insecta: Diptera). Backhuys Publishers.
4. Grichanov I.Ya. 2010: Caucasian Entomol. Bull., 6 (2), 209–212; doi:10.23885/1814-3326-2010-6-2-209–212
5. Grichanov I.Ya., Negrobov O.P. 2018: Caucasian Entomol. Bull., 14 (1), 95–104; doi:10.23885/1814-3326-2018-14-1-95-104

NOTES



COCKROACH FAUNA FROM MID-CRETACEOUS KACHIN AMBER: STATE OF THE KNOWLEDGE

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Keywords: Blattodea, Cretaceous, Myanmar amber, Dictyoptera

The order Blattaria comprises approximately 4,500 living species of cockroaches and 2,700 species of termites (suborder Isoptera) (1) which makes it the eighth largest order of insects. Blattodea *s. str.* and their relatives- mantises (suborder Mantodea) are classified within the superorder Dictyoptera, diverse and ecologically important group of insects with a long evolutionary history. Fossil evidence of cockroaches dates back to the Carboniferous period, and they have undergone numerous cascades of significant morphological and ecological diversification since then.

Myanmar amber, also known as Burmese amber, is a particularly rich source of fossilized insects and has yielded many significant findings in recent years. In this amber, we can see relict phyloblattid cockroach species, representatives of ancient groups that originated in the Carboniferous. Families Alienopteridae, Manipulatoridae went to extinction probably due to trophic changes related to Angiosperm Terrestrial Revolution. The superfamily Corydioidea and to some extant families Ectobiidae and Blaberidae were well-established in mid-Cretaceous. In total, we know 17 families and 79 species formally described from Myanmar amber.

In comparison with other Cretaceous ambers, the presence of similarities with specific localities is observed (2- for comparison of Jordanian, Lebanese and Syrian ambers). The unique taxa for Myanmar amber are the families Olidae, Fractaliidae, Pabuonqedidae and Ensiferoblattidae, which were not observed in any other locality. From the living families, Nocticolidae is recorded only from Myanmar amber. The taxa *Sivis*, *Mongolblatta* and *Perlucipecta* (all Mesoblattinidae) had Laurasian distribution. On the other hand, taxa such as *Jantaropterix* (Umenocoleidae) is present in both Laurasian and Gondwanan ambers. Possible exception is *Alienopterix hungaricus* (Alienopteridae) which is exclusively Gondwanian.

In conclusion, the majority of cockroaches preserved in Myanmar amber can be classified as members of extinct taxonomic groups. The composition of species exhibits a transitional nature between the Mesozoic and Cenozoic faunas. Ongoing research in this area promises to yield further insights into the ecology, behavior, and biogeography of Cretaceous cockroaches.

References

1. Beccaloni G.W, Eggleton P. 2011: Zootaxa, 3148, 199–200; doi:10.11646/zootaxa.3703.1.10
2. Sendi H. et al. 2023: Biologia, (in press); doi:10.1007/s11756-023-01357-y

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“NECROPHAGOUS TRAP” – A CASE STUDY ON CRETACEOUS AMBER WITH LIZARD HOLOTYPE *OCULUDENTAVIS NAGA*

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Keywords: Phoridae, trophic behavior, sticky traps, taphonomy, syninclusions

Sticky resin acts as an entomological trap, but sometimes it captures not only arthropods but also small vertebrates. Resin can be considered a behavior trap, which is exceptional among the few known examples. Resin pieces result from the accumulation of distinct resin flows, implying that the biota remains were trapped at different times. Thus, any potential biological relationship or behavior should be carefully interpreted since the recorded organisms did not necessarily interact during their lives.

In this study, we analyzed in detail an amber piece containing the lizard holotype *Oculudentavis naga* Bolet et al., 2021 and many flies (Fig. 1), and found that it consists of 13 layers, each representing different resin flows, with over 130 bioinclusions[1]. Layer 12 was formed with an “open window” above the neck of the *Oculudentavis* carcass embedded in that layer, which was not well covered by the corresponding resin flow, and emitted a decomposing odor that could have attracted a heterogeneous swarm of flies. The fly assemblage was most likely composed of necrophagous and/or predatory individuals that were feeding on the soft parts of the lizard and were abundantly trapped on the external surface of layer 12. Subsequently, a resin flow (layer 13) covered and preserved what we refer to as the “necrophagous trap”.

To describe all insects that appear together in an amber piece, we typically use the useful concept of syninclusion. However, if we aim to determine whether the various animals trapped inside the amber interacted with each other during their lives, we must be more precise about the amber layers’ origin time. Therefore, we have developed two new categories to increase the accuracy of palaeoecological inferences:

Eusyninclusions: “true”- bioinclusions present in a single layer of an amber piece, and

Parasyninclusions: “alongside”- bioinclusions present in all other different layers of an amber piece in respect to a defined layer that contains eusyninclusions by definition.

The term syninclusion is adequate if the focus of the research does not concern intraspecific or interspecific animal relationships, and if distinguishing between layers is less relevant or if the amber piece does not contain potential evidence of such relationships.

The flies around and in relation to the neck, trapped as eusyninclusions of layer 12 (Phoridae and Empidoidea flies), are poorly preserved compared to the parasyninclusions in the amber piece (the rest of bioinclusions not present in this layer 12). Most likely, the poor preservation is due to the action of ammonia, from the lizard carcass in this case, that can affect arthropods at a cellular and subcellular level in contact with water molecules.

Necrophagous and predatory phorids are common in amber. In our study of 20 Cretaceous amber pieces preserving lizards, all contained flies, but ants were absent. This was unexpected since Eocene and Miocene amber with lizards have been found to contain both flies and ants. Furthermore, in our studies using yellow sticky traps, which behave similarly to resin[2,3], ants and flies are the most frequently observed necrophagous animals around the lizard carcasses.

In conclusion, we describe the presence as eusyninclusions of flies in close relation to lizard bodies in Cenomanian amber; however, Cretaceous ants have never been recorded in similar circumstances suggesting that the early ants would not yet have a trophic or foraging strategy to search for vertebrate carcasses and to eat carrion, unlike in the current myrmecofauna.

Fig. 1. Cretaceous amber piece containing the lizard holotype *Oculudentavis naga* Bolet et al., 2021 and many flies.

References

1. Solórzano-Kraemer M.M. et al. 2023: Sci. Rep., 13 (1), 2907 (2023). doi.org/10.1038/s41598-023-29612-x
2. Solórzano-Kraemer M.M. et al. 2015: PLoS ONE 10 (3), e0118820 doi.org/10.1371/journal.pone.0118820
3. Solórzano-Kraemer M.M. et al. 2018: Proc. Natl. Acad. Sci. USA 115 (26), 6739–6744. doi.org/10.1073/pnas.1802138115

MUSEUM OF AMBER INCLUSIONS UNIVERSITY OF GDAŃSK – DISCOVERIES AND POTENTIAL

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Twenty-five years ago, thanks to the cooperation between amber workers, amber collectors and scientists, a scientific collection of inclusions preserved in fossil resins began to form under the auspices of the University of Gdansk[1]. The aim of the collection was to gather scientific specimens, so that they would not go to Warsaw or Malbork, so that Gdańsk would have its own amber collection! The beginning and its first collection being that of Professor Ryszard Szadziewski, then head of the laboratory. The collection he donated consisted of 58 pieces of Baltic and 5 pieces of Dominican amber, containing a total of 133 plant and animal inclusions. The second gift shaped the character of our collection – 50 kg of raw amber donated by Mr and Mrs Kalandyk set the direction of the collection. Since its beginning, the purpose of the collection was for research, research on amber, mainly Baltic amber but research on its inclusions. And this seemingly insignificant gift changed the image of the 'amber forest' completely, showing how different it was from previous perceptions[2]. This gave rise to the realisation that not only collecting descriptive type specimens is the most important activity of the museum, but how important it is to collect samples and specimens directly from the source, preferably raw, preferably intact. Gathering a scientific documentary collection of items is one, gathering a vivid research collection the other, and collection for educational and exhibitory purposes requires another direction.

The first and second aims are fulfilled by running a collection with access to specimens and to types. The educational role was fully completed 10 years ago, in 2013 we opened the permanent educational exhibition "Life in the Amber Forest", which last year received a multimedia guide (Application – "Wystawy Wydziału Biologii UG"). By listening to a 15-minute description, the spectator will leave the exhibition with knowledge on amber at an above-average level. The most difficult, but at the same time most fascinating role is that of research, which is only possible in scientific collections, especially university collections.

The most difficult, but at the same time the most fascinating is the research role, only possible in scientific collections, especially university collections, such as MAIG – Museum of Amber Inclusions University of Gdańsk is. In order to be such, from the beginning MAIG developed a laboratory, with tools for preparation, observation, and documentation of samples and inclusions. Fossil Resins Laboratory, with a variety of grinding, polishing and cutting tools makes it possible to prepare any fossil resin, to whatever dimensions are required. The research collection means not only the availability of tools, it means also the procedures applied in gathering, elaborating, and treatment of the samples and research material gathered in the collection.

The individual inclusion itself, its identification, description of the tiny body entombed in amber, and formal description, if it represents a new taxon, all these doings are important, but these are more spectacular if given in the context of whole amber nodule, or in context of deposit from which the sample comes[2,3,4]. Data on samples elaborated, inclusions and syninclusions, unsorted samples of raw material from known deposits of Baltic amber – all these are at the disposal of willing researchers. One can take a look on them, prepare them for further examination and elaboration, document and be preserved. We have 162 type specimens[5], carefully stored in fireproof cabinets, available for study; we hope to have dozens more soon. Microinclusions are stored and available for further study, and these have potential to solve at least some Baltic amber mysteries. A sample of Eocene amber from the Lublin area deposits await more deep exploration and elaboration. For the inquisitive, there are boxes of Baltic amber from Quaternary deposits in Pomerania prepared for research. Another sample needing of elaboration is the raw material from the Bitterfeld deposit. A portion of 5 kg of Miocene amber from Ethiopia, which has already proved to be a very interesting source of fossils awaits further studies.

Fossil resins themselves, their inclusions at any scale and taxonomic placement, and their geochemical and depositional context are invaluable resources for palaeobiology, palaeoecology, palaeodiversity, and palaeoclimatology studies. The scientific potential of the fossil resin material, the scientific potential of the research collection and the MAIG laboratory are ready for exploration and available for researchers.

References

1. Sontag E. 2013: The collection of animal inclusions at the University of Gdańsk, Museum of Amber Inclusions, in Kosmowska-Ceranowicz B. et al. (Eds) The International Amber Researcher Symposium. Amber. Deposits-Collection-The Market, Gdańsk. Gdańsk International Fair Co.
2. Sontag E. 2003: Acta zool. Cracov. 46 (Suppl. 1), 431–440.
3. Szwedo J., Sontag E: 2009: Denisia 26, 155–169.
4. Szadziewski R. et al. 2018: Baltic amber – treasure of the Bay of Gdańsk. Związek Miast i Gmin Morskich.
5. https://www.muzeum.gda.pl/

EXTINCT PARASITE OF EXTINCT SCORPIONFLY – SYNCHROTRON MICROTOMOGRAPHY HELPED TO UNCOVER A HIDDEN STORY

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Keywords: Burmese amber, Cretaceous, scorpionflies, synchrotron, parasite, beetle larva

Some members of the Pseudopolycentropodidae and Dualulidae families are distinct from all other Mecoptera known to science. They have been described from the beginning of the Upper Cretaceous (~99 Ma) from Burmese amber inclusions. They are distinguished from all other scorpionflies by having only one pair of the wings, a siphonate mouthparts, and unique pattern of wing venation. The unique morphological features undoubtedly suggest a behavioural and morphological convergence to the flies[1]. The habitat of those scorpionflies most likely enabled them to fly quickly and agilely, and their mouthparts are similar to modern nectar-feeding flies. In the abdomen of the *Pseudopolycentropodes burmiticus* Grimaldi and Rasnitsyn, 2015[2] we found a parasite. The use of synchrotron microtomography made it possible to reconstruct the details of the structure and shows the first spectacular case of parasitism on extinct Mecoptera. The reconstruction of the parasite made possible by such advanced imaging allowed verification of the parasite's affiliation and pointed to a beetle larva, probably belonging to suborder Polyphaga, recently unknown. On the biology of both of these groups we know only as much as can be inferred from fossil data. This is the first direct evidence for parasitic interaction between Coleoptera and Mecoptera in the past. The amber inclusion was acquired before June 2017, prior to the armed conflict and the escalation of the ethnic strife in the area of Myanmar.

References

1. Grimaldi D. et al. 2005: Insect Syst. Evol., 36, 443–458; doi: 10.1163/187631205794761021
2. Lin X. et al. 2019. *Nature Com.* 10, 1235, 14; doi: 10.1038/s41467-019-09236-4

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X-RAY MICRO-COMPUTED TOMOGRAPHY REVEALS HIDDEN PALEODIVERSITY OF MINUTE HOODED BEETLES (COLEOPTERA: CORYLOPHIDAE) IN EOCENE BALTIC AMBER

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Keywords: Baltic amber, beetles, Coccinelloidea, micro-CT, palaeoentomology

Corylophidae, minute hooded beetles, is a small but cosmopolitan family of beetles containing 28 genera and around 300 species, which are distributed worldwide[1]. They are fungivores both as larvae and adults, and thought to be mould feeders[2]. Due to its cryptic lifestyle and minute body size (usually around 0.5–2.5 mm) their evolution and taxonomy caught little attention of researchers.

The fossil record of Corylophidae is scarce. The oldest member of the family, *Xenostanus jiangkuni* Li, Szawaryn & Cai, 2022, representing a new extinct tribe Xenostanini, has been found and described from the mid-Cretaceous Myanmar amber[3]. The second source of fossil corylophids is Eocene Baltic amber. Representatives of the family have been reported from this fossil resin more than a century ago by Klebs (1910), who mentioned a single specimen of the modern genus *Corylophus* Leach, 1833. Later, Larsson (1978) and Kulicka & Ślipiński (1996) mentioned several additional specimens of Corylophidae from Baltic amber, however, none of the representatives of this family was described. Alekseev[4] described for the first time an extinct member of Corylophidae, and placed in modern genus *Clypastraea* Haldeman, 1842 under the name *Clypastraea primainterpares* Alekseev, 2016. That fossil species was described from a piece of Baltic amber collected on the Sambian peninsula. Further materials from Bitterfeld (Saxon) amber documented presence of *Clypastraea* members in that fossil resin as well[4]. In the original description, the holotype of *C. primainterpares* was examined with an optical microscope only, some characters of external morphology were also not specified and further investigation by micro-computer tomography was necessary. Subsequently Kirejtshuk et al.[5] described another Eocene corylophid from the Insect Limestone of the Isle of Wight, *Orthoperites antiquus* Kirejtshuk & Kurochkin, 2019. According to the authors it resembles modern genus *Orthoperus* Stephens, 1829, but the state of preservation of the specimen hampers any further conclusions.

Most of the Corylophidae are very tiny beetles and even extant taxa, especially at the species level, can cause serious problems with identifications. Very frequently dissection of genitalia is mandatory to distinguish species level taxa, but also other morphological details such as presence and form of vestiture or scales on elytra, various ratios between morphological structures require preparation of slides or even usage of scanning electron microscopy (SEM)[1,2]. These techniques are not applicable when examining fossil specimens. Thus, we used an X-ray micro-computed tomography (µCT) to examine fossil *Clypastraea* specimens embedded in Baltic amber (Fig. 1A). Usage of that technology allowed us to examine tiny morphological structures which are commonly used in taxonomy of modern Corylophidae species such as structure of antennae, shape of prosternal chinpiece, number of tarsomeres, shape of scutellar shield or even male genitalia (Fig. 1B). As a result we confirmed taxonomic placement of previously described *C. primainterpares* Alekseev and described two new species of *Clypastraea*.

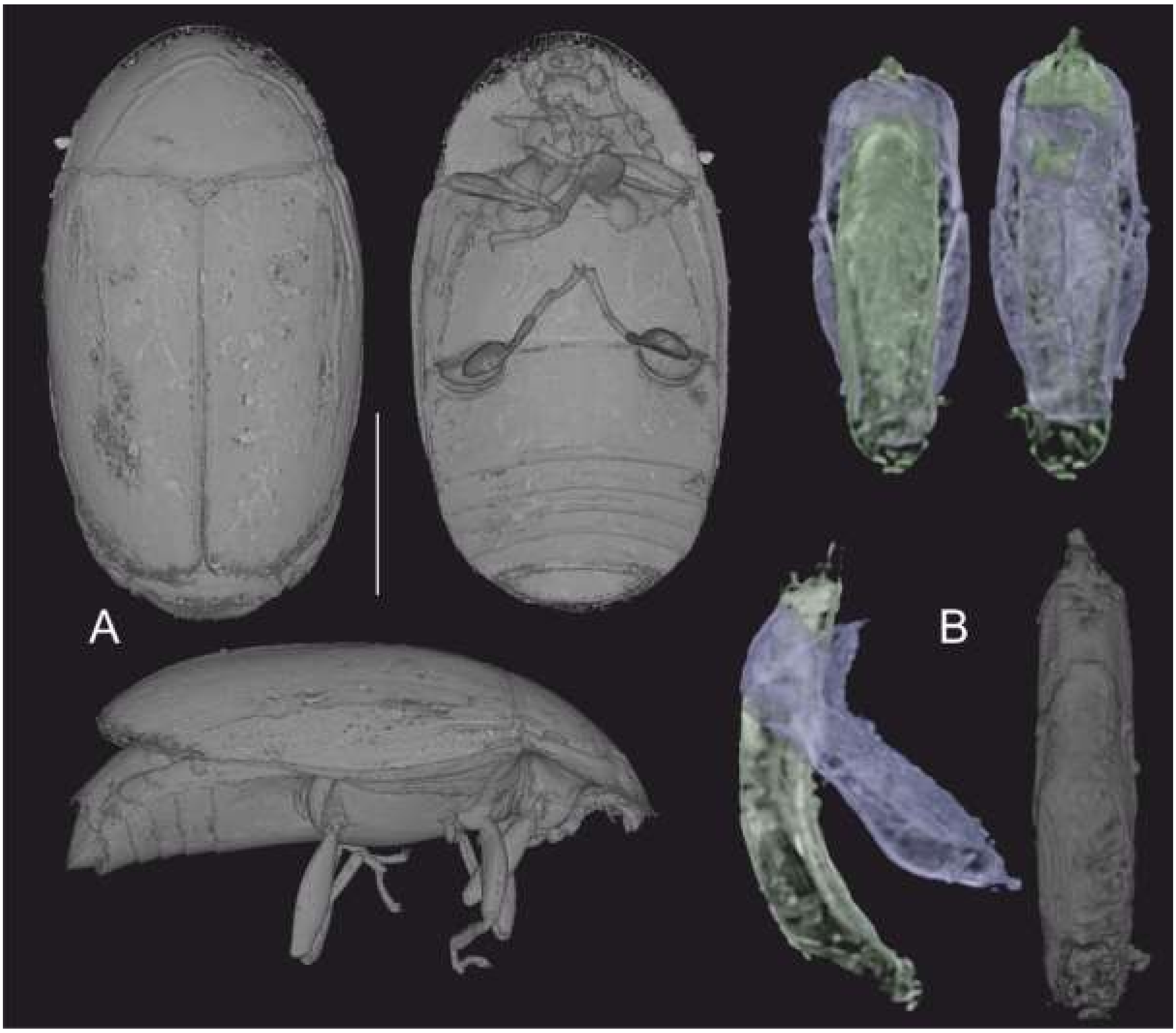

Figure 1. A – *Clypastraea primainterpares* Alekseev, micro-CT habitus reconstruction; B – *Clypastraea* sp., micro-CT male genitalia reconstruction. Scale bar = 1mm.

References

1. Ślipiński A. et al. 2009: Syst. Entomol., 34 (3), 409–433; doi:10.1111/j.1365-3113.2009.00471.x
2. Bowestead S. 1999: Instrument. biodivers., 3, 1–203.
3. Li Y.-D. et al. 2021. Arthropod Syst. Phylo., 80, 411–422; doi:10.3897/asp.80.e81736
4. Alekseev V.I. 2016: Balt. J. Col., 16, 21–26.
5. Kirejtshuk A.G. et al. 2019: Earth Environ. Sci. Trans. R. Soc. Edinb., 110 (2-3), 405–492; doi:10.1017/S1755691018000865

MICRO-CT SCANNING REVEALED A NEW COCCINELLIDAE REPRESENTATIVE FROM BALTIC AMBER, A PUTATIVE COMMON ANCESTOR OF TWO EXTANT TRIBES

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Keywords: Baltic amber, micro-CT, ladybird beetles, palaeoentomology, Eocene

The ladybird beetles (Coccinellidae) are divided into three subfamilies: Microweiseinae, Monocoryninae and Coccinellinae[1]. Well-known, brightly coloured beetles like *Coccinella septempunctata* Linnaeus, 1758 or *Harmonia axyridis* (Pallas, 1773) belong to the large, widely distributed subfamily Coccinellinae. The subfamily Microweiseinae comprises tiny beetles, frequently cryptically coloured (brown or black, without any maculation), which are often not recognized by non-specialists. They resemble some fungivorous beetles from the family Endomychidae or Corylophidae, rather than typical ladybird beetles. The third subfamily Monocoryninae was recognized recently[1] and is represented by a single south Asian genus so far. Although ladybird beetles are well-known insects, their evolution is still poorly understood. Recent molecular analyses raised more questions than solutions regarding their natural classification. In addition, their fossil record utill recently was almost unknown. The oldest representatives were discovered in the Early Eocene amber of Oise (~53 Mya) and classified in genera *Rhyzobius* Stephens, 1832 (two species) and *Nephus* Mulsant, 1846 (one species)[2], both from the subfamily Coccinellinae. So far, the richest source of fossil ladybirds is Baltic amber (~47.8–33.9 Mya) where they have been found since the 19th century (Larsson, 1978). Recent studies of Baltic amber inclusions revealed a variety of Eocene ladybird beetles[3,4,5] representing two subfamilies, Microweiseinae and Coccinellinae, and four extant tribes. Discovered taxa represent two modern genera *Serangium* Blackburn, 1889 (3 species) and *Rhyzobius* (3 species), and two fossil genera *Electrolotis* Szawaryn et Tomaszewska 2020 (1 species) and *Baltosidis* Szawaryn 2021 (3 species). Most of them are small to minute size beetles which hampers examination without high magnification microscopy or even micro-CT scanning.

We used micro-CT scanning to reconstruct another minute coccinellid beetle, which was preserved in sub-optimal condition, with key characters hidden under cracks and milky veils. Micro-CT reconstruction revealed detailed morphological structures. To find out the phylogenetic position of that new fossil ladybird beetle we conducted a cladistic analysis. We used 41 representatives of modern lady beetles and scored 67 morphological characters. Parsimony analysis (MP) was conducted in TNT under standard conditions. As a result we obtained a single tree with our fossil specimen placed at the base of a clade combining members of two modern tribes Cephaloscymnini and Shirozuellini. Both tribes are quite distinct groups of Coccinellidae with modified mouthparts and peculiar characters of the head capsule, however they have never been regarded as sister taxa. Moreover, Cephaloscymnini are distributed solely in the Neotropics, while Shirozuellini in the Oriental Realm. Thus the position of the new fossil Coccinellidae is interesting and we regard it as a common ancestor of both tribes, sharing with time such characters as very large eyes with inner eye margin straight, very elongate maxillary palp, broad prosternal process, and broad mesoventral process (broader than corresponding mesocoxal diameter).

Figure 1. Micro-CT reconstruction of a new Coccinellidae representative from Baltic amber. A – habitus, ventral, B – habitus, lateral, C – mouthparts and prosternum, ventral, D – mandibles and antennae. Scale bar = 1mm.

References

1. Che L.-H. et al. 2021: Mol Phylogenet Evol, 156, 107045.
2. Kirejtschuk & Nel 2012: Zoosystem Ross, 21, 131–144.
3. Szawaryn K., Szwedo J. 2018: PalZ, 92,: 593–603.
4. Szawaryn K., Tomaszewska W. 2020: Pap Palaeontol, 6, 651–659.
5. Szawaryn K. 2021: Zool J Linn Soc-Lond, 193, 1294-1309.

THE FIRST FOSSIL LARVA OF MECOPTERA (INSECTA) – DISCOVERED IN BALTIC AMBER

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Keywords: Baltic amber, Eocene, scorpionflies, Panorpidae, immature stage. morphology

Nothing has been known about preimaginal stages of fossil scorpion flies (Mecoptera), so far. A well-preserved Panorpidae larva was discovered in the Eocene Baltic amber. Application of synchrotron microtomography, have made it possible to reconstruct the body structure of this specimen with high accuracy. The larva is eruciform, with distinct segmentation of the body and shape of antenna and annulated processes on abdominal segments points on the third/four stage of the development. The strongly sclerotised opistognathic head capsule bears protuberant compound eyes and long three-segmented antennae. The chewing mouth apparatus is well preserved with visible details of labium, labrum; mandibles, and maxillae. The first thoracic segment possesses broad tergite, thoracic legs are four-segmented with triangular tibial lobe. Abdominal segments are with dorsal annulated processes and eight pairs of abdominal prolegs. The dorsal annulated processes on the abdominal segments I-VIII are relatively short, in contrary to these processes on the three last abdominal segments, which are strong and long. Ventral prolegs on abdominal segments are relatively small and of similar size. The good condition of the specimen makes possible to follow also chaetotaxy system. The larva belongs without doubts to the family Panorpidae. The set of visible morphological characters points on the closest affinity of larva to larvae of genera *Cerapanorpa* and *Panorpa* without possibility of certain assignment to any of extant genus of Panorpidae. It is highly likely that discovered larva may belongs to extinct genus *Baltipanorpa*.

NOTES

MIOCENE FOSSIL RESINS - WHAT THEY CAN SAY ON MODERN-DAY CLIMATIC CRISIS

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The Miocene was the first geological epoch of the Neogene period, extending from about 23.03 to 5.333 million years ago (Ma). It was a period in which the climate cooled slowly but still had a global warming interval, relative to the present day. Miocene climate was dynamic: long early and late glaciation periods included a ~2 million year-long greenhouse period in c. 17-15 Ma – the Middle Miocene Climatic Optimum (MMCO). The MMCO represented one of the major warming periods in the Cenozoic and was accompanied by a positive increase in stable carbon isotopes. The geological record indicates that mid-latitude temperatures were about 5-6°C higher than today during MMCO[1]. This magnitude of warming corresponds to the warming projected for the next century.

The continents' configurations and the mountains' topography were shifting towards modern conditions, and many floristic and faunal elements were recognisable as contemporary.

The period of MMCO was also the period of production and accumulation of resins, which fossilised and deposited, are currently recognised as Dominican amber, Mexican amber, Zhangpu amber, Sumatra/Borneo amber or Ethiopian amber, to mention some. In most cases, these resins contain various types of inclusions, of which the best elaborated are arthropods. Inclusions in fossil resins often serve as proxies in studying changes in the palaeobiotas. However, what is preserved is not always an outright representation of the ecosystem, and interpretation of the findings may pose some difficulties[2]. Amber trap is selective, and taxonomic and biotic images recorded in samples are skewed[3]. But being aware of this bias, amber inclusions are still an excellent and enormous source of palaeobiological and palaeoclimatological information.

Arthropod inclusions in Dominican amber and Mexican amber are relatively well known, and with all reservations, these could be compared with their recent counterparts, representing groups recorded as fossils. The presence of particular arthropods, present in the areas during the MMCO, entombed in fossil resins of the *Hymenaea*, but now absent, compared with distributional and ecological patterns offered by their recent relatives, can bring essential conclusions. Interesting results were already signalled from the Fotan group deposits, where adpressions of plants and amber rich in inclusions co-occur[4]. The record shows that the mid-Miocene rainforest in China was more widespread than previously estimated. Recent discoveries of Miocene resins in India and Vietnam, new data on resins and their deposits from Indonesia, Brunei and the Philippines should shed light on the biotic and climatic changes during the MMCO in south-eastern Asia. The resins were identified as derived from Dipterocarpaceae, which must have been supported by a warm, tropical climate. Tropical Asia is well-known and unique for the importance, and Neogene diversity of the Dipterocarpaceae, and its forests are composed of species primarily in this family. Amber from the early Miocene of Ethiopia is a new and invaluable source of data, the first results present a variable and rich set of inclusions. Recent palaeobotanical discoveries suggest the presence of legume dominant wet tropical forest at the time of amber formation in the northwestern plateau of Ethiopia[5]. Ethiopian amber is derived from a kind of legume tree, *Hymenaea* or a close relative, and recent palaeobotanical data could be a valuable reference to the reconstruction and interpretation of the amber forest of Ethiopia. Miocene ambers originate from areas grown by megathermal wet forests, species-rich, but sometimes with a dominance of a single canopy species. Differences in regional evolutionary histories are implied by biogeography: most of Africa's monodominance-forming species are Amherstieae-tribe legumes; monodominance in Neotropical forests occur among diverse taxonomic groups, often legumes, but rarely Amherstieae, and monodominance in Southeast Asian forests occurs mostly among Dipterocarpaceae species. Megathermal rainforests are recognised as evolutionary museums for biodiversity, amber and its inclusions can give a word on their largely unknown histories, shaped under conditions of global warming during MMCO. Understanding these past events, palaeohabitas and their functioning at MMCO times are crucial to understanding the current global climatic changes.

References

1. Flower B.P., Kennett J.P. 1994: Palaeogeogr. Palaeoclimatol. Palaeoecol., 108 (3-4), 537–555; doi:10.1016/0031-0182(94)90251-8
2. Szwedo J., Sontag E. 2009: Denisia, 26, 155–169.
3. Solórzano-Kraemer M.M. et al. 2018: Proc. Natl Acad. Sci. U.S.A., 115 (26), 6739–6744. doi:10.1073/pnas.1802138115
4. Wang B. et al. 2021: Sci. Adv., 7, eabg0625; doi10.1126/sciadv.abg0625
5. Pan A.D. et al. 2023: PLoS ONE 18 (1), e0279491; doi: 10.1371/journal.pone.0279491

DAMSEL BUG FROM EOCENE LUBLIN AMBER, MAY BE NOT SUCH A DAMSEL

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Keywords: Nabidae, Heteroptera, disparity, palaeobehaviour, palaeoecology

Clastic deposits accumulated in the Middle and Late Eocene of the Górka Lubartowska region (Lublin area, South Eastern Poland) has been recently recognized as amber source[1]. Amber found in this area brought several inclusions not reported from similarly aged amber from the Gulf of Gdańsk, Bitterfeld or Ukraine.

The Heteroptera family Nabidae – the damsel bugs, contains about 30 genera and 400 species, subdivided in two subfamilies and up to 8 tribes[2,3]. The internal classification has been unclear and controversial, confusing researchers in various fields. Damsel bugs are medium sized, rarely exceeding 10 mm, usually elongate, soft-bodied, represent a guild of generalist arthropod predators, found in different terrestrial ecosystems. Many damsel bugs catch and hold prey with their forelegs, similar to mantids. The elongated, oval head has compound eyes placed close to the edge of the hemelytrae and the appendages located on a flat vertex. The relatively long and thin antennae, in addition to the four proper antennomeres, are also built up by two small intercalary insertions, located behind the first and second antennomeres. Rostrum is four-segmented, mobile, in the resting position does not adhere to the underside of the head, but arches. The pronotum towards the back widens trapezoidally, its the anterior section is developed into a collar; scutellum is small, triangular. Hemelytrae variable form macropterous to brachypterous, without costal break and cuneus. The pro- and mesofemora are sometimes thickened, tarsi three segmented and *fossula spongiosa* (bristly appendage), on the tips of pro- or sometimes pro- and mesotibiae are present. Males of most species have an Ekblom's organ behind the posterior opening of the pygophore and set of bristles on tips of metatibiae, involved in the distribution of pheromones from the rectal glands[2]. In some Nabidae (Prostemmatinae, Carthasini) a special behavior called traumatic insemination (TI), do occur[4].Oldest fossils record of the family is *Cretanazgul camillei* Garrouste *et al*., 2020 from Cenomanian, Kachin amber and there are two species known from Baltic amber – '*Nabis*' *lucidus* Germar et Berendt, 1856 and *Metatropiphorus succini* (Jordan, 1952)[5].

A piece of amber from Górka Lubartowska contained a fossil of true bug presenting features of the family Nabidae, but also features not present in modern damsel bugs, the most striking are stalked eyes, tarsi short, 2-segmented and *fossula spongiosa* developed on all legs. Some morphological details of the fossil are shared with representatives of Prostemmatini (Prostemmatinae), the others with Carthasini and Arachnocorini (Nabinae). Further analysis of morphological features of a new damsel bug brought some indications to its palaeoecology, palaeobehaviour and palaeohabitat. We can assume it was a riparian bug, hunting near shorelines or the marginal growths near freshwater bodies, estuaries, and sea coast, similar to modern members of the families Leptopodidae, Saldidae, and Gelastocoridae. *Fossula spongiosa* is present on the fore and mid legs or only on the fore legs in most of Cimicomorpha, including Nabidae. In the new fossil *fossula spongiosa* is present on the tibiae of all legs. The presence of this structure on all legs is usually related TI, so we assume that such a behaviour was present in this fossil damsel bug.

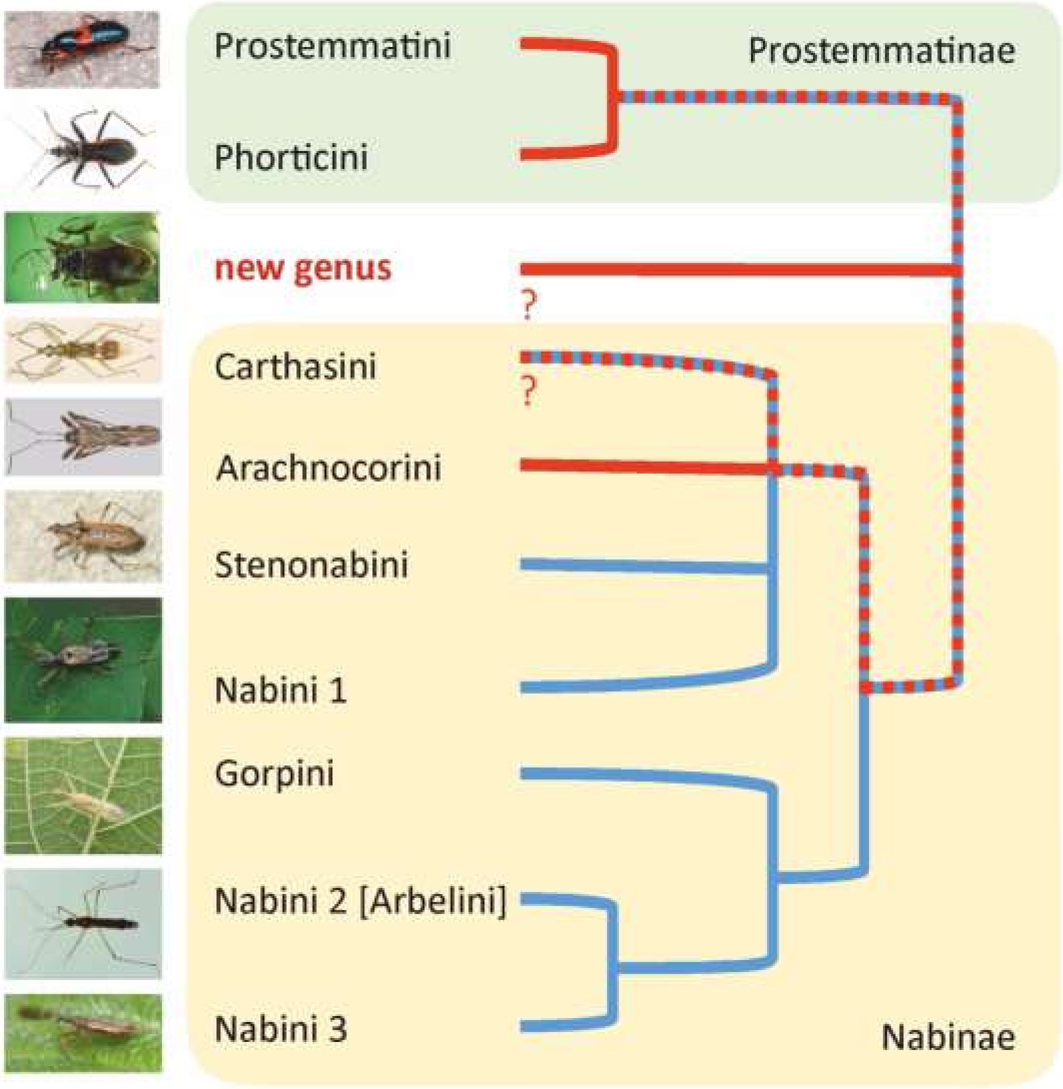

Figure 1. Relationships within Nabidae, with TI occurrences marked in red.

References

1. Słodkowska B. et al. 2022: Prz. Geol., 70 (1), 50–60; doi:10.7306/2022.3
2. Schuh R.T., Weirauch C. 2020: True bugs of the World. Siri Scientific Press.
3. Kim J. et al. 2021: Syst. Entomol., 47 (1), 1–12; doi:10.1111/syen.12512
4. Jung S. et al. 2023: Insects, 14 (3), 267, 1–15; doi.org:10.3390/insects14030267
5. PaleoBioDB 2023: Family Nabidae Costa, 1853 (true bug). https://paleobiodb.org/classic/basicTaxonInfo?taxon_no=231212

Fossil Record in Resins and Sediments
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FIRST SPILAPTERIDAE (PALAEODICTYOPTERA) FROM NAMURIAN B OF BIELSZOWICE COAL MINE, UPPER SILESIA

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Keywords: adpression fossil, Zabrze Beds, Upper Silesia Coal Basin, fossil record

The Upper Silesia Coal Basin, located in south western Poland and the north-eastern Czech Republic, is the largest coal basin in Europe, with a total area of about 7400 km^2. The basin has a triangular shape, being bounded on its western side by over thrust Devonian to Mississippian sediments of the Moravo-Silesian fold-zone, and to the north by the Lubliniec–Kraków tectonic zone. Its southern limits have been identified based on records from deep bore holes of the Carboniferous coal-bearing strata be low Miocene deposits and nappes of the Outer Carpathians. The Upper Silesia Coal Basin was part of a larger sedimentary basin located in a foreland position in front of the Moravo-Silesian orogen during Late Palaeozoic times. The Zabrze Beds (Kinderscoutian; Namurian B) are the oldest deposits of the fully terrestrial phase of sedimentation in the Upper Silesia Coal Basin (USCB) and constitute a part of the flexural Variscan fore deep USCB in fill. On the Main Anticline area this unit starts the continental stage of the basin development. The Zabrze Beds were deposited on an extensive alluvial plain probably constructed by meandering river systems[1].

Carboniferous record of insects from USCB is scarce, a few representatives of unplaced Archeorthoptera and Geraridae; Protorthoptera: Paoliidae (=Katerinkidae) and Stygneidae; Palaeodictyoptera: Breyeriidae and Homoiopteridae. The Palaeodictyoptera have been major herbivorous plant-sap sucking insects during the Late Carboniferous to the Early Permian. They were well-diversified, with at least known 50 genera in about 16 families. However, palaeodictyopteran species are generally represented by very few specimens in comparison to other clades such as the Dictyoptera or the Archaeorthoptera. Spilapteridae is regarded as one of the most species-rich of its order, comprising currently 23 genera[2], but so far no taxa of this family were recorded in USCB.

Fossil insects of the Late Carboniferous have been popularized as lost giants of the past. However, their small contemporaries are very poorly known. Here we present first record of Spilapteridae from USCB, from the collection of the Upper Silesian Museum in Bytom, representing a new genus and species of this family and first record if it from Poland. It is represented by isolated forewing, ca. 17 mm long, which is rather small in comparison with most of known Spilapteridae. The smallest species known so far is *Tytthospilaptera wangae* with fore wing length less than 10 mm, while in the largest (*Becquerelia superba*) it exceeds 85 mm[3]. Reasons of this gigantisms in insects was postulated as effect of an elevated atmospheric pO_2 on the size during the late Late Carboniferous[4], but other macro-ecological causes such as particular mating regimes, or a comparatively low level of predation pressure, might have to be considered[5]. The newly found specimen enrich the dataset to address such evolutionary questions. With new data it should be possible to adequately test the hypothesis of a global effect of an elevated atmospheric pO_2 on the size of these insects during the late Late Carboniferous *vs*. that of a lineage-specific trend possibly driven by an arms race in size[3].

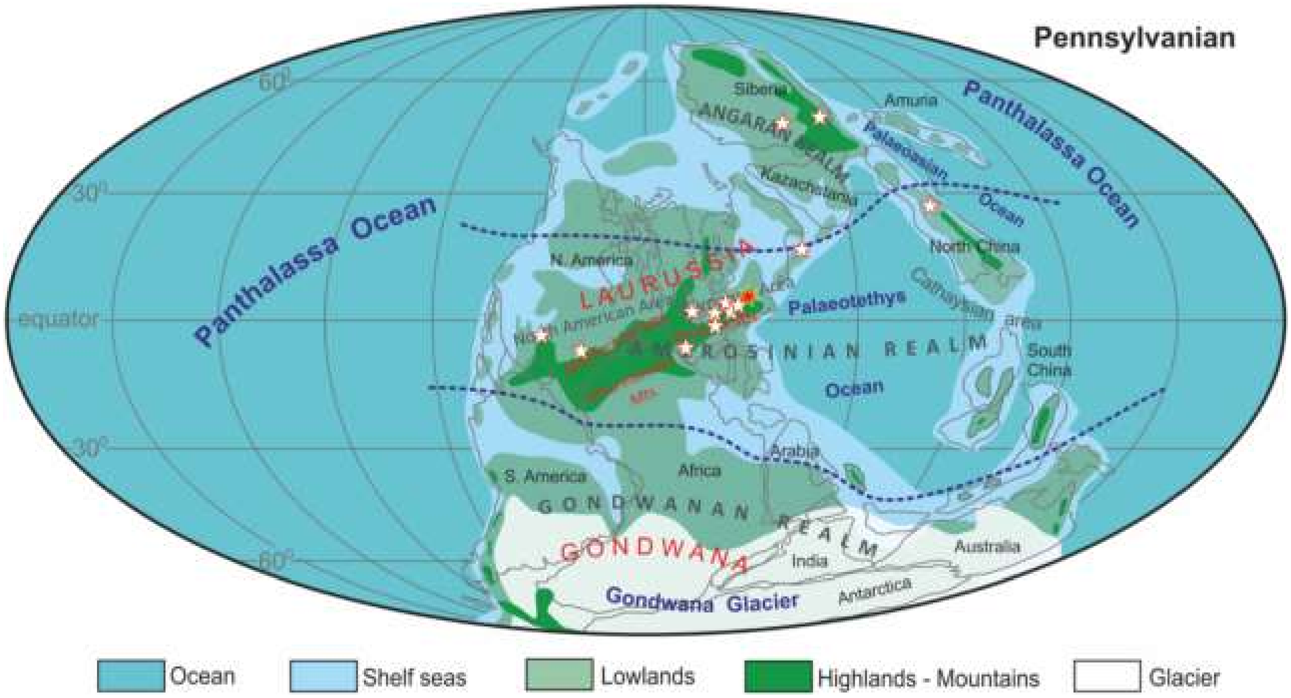

Fig. 1. Distribution of fossil Spilapteridae in the Carboniferous (white star – known places; red asterisk – a new locality in Silesia). Palaeogeography and phytochoria after Opluštil et al. 2021: Geol. Soc. Lond. Spec. Publ., 512, 813–863; doi:10.1144/SP512-2020-97.

References

1. Kędzior A. 2016: Ann. Soc. Geol. Pol., 86, 437–472. doi:10.14241/asgp.2016.020
2. PaleoBioDB 2023: Spilapteridae. https://paleobiodb.org/classic/basicTaxonInfo?taxon_no=221202
3. Liu X. et al. 2015: C.R. Palevol., 14, 346–352. doi:10.1016/j.crpv.2015.05.013
4. Clapham M.E., Karr J.A. 2012: Proc. Natl. Acad. Sci U.S.A., 109, 10927–10930. doi:10.1073/pnas.1204026109
5. Li Y. et al. 2013: Alcheringa, 37, 487–495. doi:10.1080/03115518.2013.793024

PALAEOGENE AMBERS AS SOURCE OF FOSSIL ASCOMYCETES: RECENT DISCOVERIES AND PERSPECTIVES

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Keywords: Ascomycetes, Baltic amber, Bitterfeld amber, fossil fungi

Ambers are an important source of Palaeogene ascomycetes[1]. Those delicate inclusions provide relevant clues for a better understanding of the evolution of extant lineages and witness different morphologies and lifestyles[2]. These fungi formed a broad range of ecological niches and mutualistic, symbiotic (lichens), parasitic (Laboulbeniomycetes), or plant-pathogenic associations. The main characteristics of these fungi are microscopic sexual structures called asci or anamorphic (asexual) forms. Ascomycetes from Baltic and Bitterfeld ambers include representatives of the classes Coniocybomycetes, Dothideomycetes, Eurotiomycetes, Laboulbeniomycetes, and Lecanoromycetes[3, 4, 5]. Here we present an overview of morphology and systematic affinities of several newly discovered ascomycete inclusions with a focus on insect-associated fungi. Among these new fossils is a new specimen of the order Laboulbeniales which extends the stratigraphic range of this lineage to the Eocene. We applied light microscopy and synchrotron X-ray microtomography to enlighten minute structures which allowed the assignment of the fossils to extant genera.

References

1. Beimforde, C. et al. 2014: Mol. Phylogenet. Evol. 78: 386-398; doi:10.1016/j.ympev.2014.04.024
2. Perreau, M. et al. 2021: Sci. Rep. 11, no. 1: 2672; doi:10.1038/s41598-020-79481-x
3. Kettunen, E. et al. 2018: Pap. Palaeontol., 5, 3, 365–389; doi:10.1002/spp2.1238
4. Rikkinen, J. et al. 2018: Geobios 51, no. 5: 469-479; doi:10.1016/j.geobios.2018.08.009

5. Tischer, M. et al. 2019: Fungal Biol. 123, no. 11: 804-810; doi:10.1016/j.funbio.2019.08.003

NOTES

ECHOES FROM THE CRETACEOUS: NEW FOSSILS SHED LIGHT ON THE EVOLUTION OF HOST DETECTION AND CONCEALED OVIPOSITOR APPARATUS IN THE PARASITOID WASP SUPERFAMILY ORUSSOIDEA (HYMENOPTERA)

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Keywords: Eocene fossils, Cretaceous fossils, parasitoid wasp evolution, synchrotron scanning

We report two female members of parasitoid wasp family Orussidae from Baltic amber; these are the first records of female orussids from this deposit. One specimen can be placed in the extant genus *Orussus*, the other represents a previously undescribed genus. We examined the external anatomy under light microscopy and also conducted synchrotron scanning to elucidate relevant parts of the internal anatomy. The fossils display a number of modifications in the antenna and foreleg correlated with the specialized host detection mechanism, and in the ovipositor apparatus as well as in the thorax and abdomen for accommodating the internalized ovipositor. Bayesian phylogenetic analyses place both fossils as crown group members of the Orussidae, supported by the features mentioned above as well as other traits. The recently described stem group orussoid fossils from Burmese amber, the probable female †*Cretorussus vilhelmseni* and probable male †*Burmorussus mirabilis* (both placed in Burmorussidae) were also included in the data set. By comparing the Baltic amber females with †*Cretorussus*, it is possible to trace the progressive refinement of the echolocation mechanism through reductions in the number of antennomeres and tarsomeres in the foreleg. Unfortunately, †*Cretorussus* does not have the posterior part of the abdomen with the ovipositor preserved. Nevertheless, it is possible to infer that the putative echolocation mechanism for host detection evolved at least 100 Ma ago, whereas the concealed ovipositor apparatus has not been documented in fossils older than approx. 35 Ma.

Fig. 1. *Orussus* n. sp. in Baltic amber, female, lateral view.

THE LIMONIIDAE OF EOCENE LUBLIN AMBER

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Keywords: fossil insects, Tipulomorpha, Cenozoic resin, new deposit, new species

Limoniidae Speiser, 1909 is a widely distributed family comprising approximately 11 000 species of slender craneflies associated with moist habitats. While the oldest discovery comes from the Upper Triassic, they are abundant among Diptera fossils from the Jurassic, Cretaceous and Paleogene periods. Records from various deposits, including both amber and compression fossils, provide valuable information about the morphology, ecology and evolution of these insects over time, which gives a solid basis for inferring their existing diversity.

Recently, we discovered several representatives of the Limoniidae from a newly exploited deposit of amber mined in south-eastern Poland, near Lublin. The results of geological research published last year indicate the Middle - Late Eocene (Bartonian-Priabonian), but above all that, it is a primary deposit within this sedimentation basin, that was not moved by Pleistocene ice age. In the Eocene, the eastern branch of the shallow epicontinental sea reached the area of Central Europe, along with today's Lublin region, where the existence of an archipelago of large islands with shores covered with rich subtropical vegetation and the beginning of the formation of Lublin amber was assumed[1].

As for the onset of dipterological research on the Eocene Lublin amber, a relatively high diversity of Limoniidae was recorded. Among the seven specimens, we were able to determine representatives of three subfamilies and five genera: Limnophilinae Bigot, 1854 with *Pseudolimnophila* Alexander, 1919 and *Tanysphyra* Loew, 1850; Limoniinae Speiser, 1909 with *Dicranomyia* Stephens, 1829 and *Trichoneura* Loew, 1850 and Dactylolabinae Alexander, 1920 with *Dactylolabis* (*Eobothrophorus*) Podenas, 2003. While some of them belong to species already described from Baltic amber[2,3,4,5], others show morphological features suggesting that they are hitherto unknown to science.

References

1. Słodkowska B. et al. 2022: Prz. Geol., 70, 50–60; doi:10.7306/2022.3
2. Alexander C. P. 1931: Crane flies of the Baltic Amber (Diptera). Bernstein Forsch., 2, 1-135.
3. Krzemiński W. et al. 2010: Acta Geol. Sin.-Engl., 84 (4), 768-771; doi:10.1111/j.1755-6724.2010.00264.x
4. Kania I. 2014: Acta zool. cracov., 58 (1), 1-19; doi:10.3409/azc.58_1.01
5. Kania I. 2015: Zool. J. Linn. Soc., 170, 748–778; doi: 10.1111/zoj.12120

NOTES

TYPES OF FOSSIL SPECIES IN MAI UG COLLECTION [MAIG]

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Insecta

Coleoptera

Family Brentidae

1. *Toxorhynchus europeoeocenicus* BUKEJS *et* LEGALOV, 2020 (Baltic amber, Rovno deposit); holotype, No. MAIG_6684

Family Cantharidae

2. *Lycocerus elzbietae* KAZANTSEV, 2020 (Baltic amber); holotype, No. MAIG_6683
3. *Lycocerus jonasi* KAZANTSEV, 2020 (Baltic amber); holotype, No. MAIG_6681
4. *Malthodes gedanicus* FANTI *et* SONTAG, 2019 (Baltic amber); holotype, No. MAIG_5973
5. *Podosilis gedaniensis* KAZANTSEV, 2020 (Baltic amber); holotype, No. MAIG_6277
6. *Rhagonycha acarigera* KAZANTSEV, 2020 (Baltic amber); holotype, No. MAIG_6682

Family Cerambycidae

7. *Acanthoglyptus picollus* ALEKSEEV *et* VITALI, 2020 (Baltic amber, Sambia deposit); holotype, No. MAIG_6080

Family Chelonariidae

8. *Chelonarium dingansich* ALEKSEEV *et* BUKEJS, 2021 (Baltic amber); holotype, No. MAIG_6696

Family Chrysomelidae

9. *Eocenocolaspis aurichalceus* BUKEJS, MOSEYKO *et* ALEKSEEV, 2022 (Baltic amber, Sambia deposit); holotype, No. MAIG_6813

Family Cleridae

10. *Aberrokorynetes oceanojubilaei* KOLIBÁČ *et al*., 2021 (Baltic amber, Sambia deposit); holotype, No. MAIG_6803

Family Coccinellidae

11. *Baltosidis damzeni* SZAWARYN, 2020 (Baltic amber); holotype, No. MAIG_5988, paratypes, No. MAIG_3687, No. MAIG_5967
12. *Electrolotis hoffeinsorum* SZAWARYN *et* TOMASZEWSKA, 2020 (Baltic amber); paratypes, No. MAIG_5972, No. MAIG_5996
13. *Rhyzobius sontagae* SZAWARYN *et* TOMASZEWSKA, 2020 (Baltic amber); holotype, No. MAIG_2047
14. *Serangium gedanicum* SZAWARYN *et* SZWEDO, 2018 (Baltic amber); holotype, No. MAIG_5674
15. *Serangium kalandyki* SZAWARYN, 2019 (Baltic amber); holotype, No. MAIG_1535
16. *Serangium twardowskii* SZAWARYN *et* SZWEDO, 2018 (Baltic amber); holotype, No. MAIG_5670

Family Cryptophagidae

17. *Atomaria (Anchicera) alekseevi* LYUBARSKY *et* BUKEJS, 2022 (Baltic amber); holotype, No. MAIG_6831
18. *Atomaria (Anchicera) gedanicola* LYUBARSKY *et* PERKOVSKY, 2013 (Baltic amber); holotype, No. MAIG_897
19. *Atomaria (Anchicera) perkovskyi* LYUBARSKY *et* BUKEJS, 2022 (Baltic amber, Rovno deposit); holotype, No. MAIG_6832

Family Curculionidae

20. *Baltacalles triumurbium* BUKEJS, ALEKSEEV *et* LEGALOV, 2020 (Baltic amber, Sambia deposit); holotype, No. MAIG_6274
21. *Baltocoeliodes sontagae* LEGALOV *et* BUKEJS, 2018 (Baltic amber); holotype, No. MAIG_5952
22. *Palaeoanoplus horridus* LEGALOV, 2021 (Baltic amber, Sambia deposit); paratype, No. MAIG_6701
23. *Paonaupactus katyae* LEGALOV, NAZARENKO *et* PERKOVSKY, 2019 (Baltic amber, Rovno deposit); holotype, No. MAIG_5981

Family Dermestidae

24. *Attagenus (Aethriostoma) gedanicissimus* BUKEJS, HÁVA *et* ALEKSEEV, 2020 (Baltic amber, Rovno deposit); holotype, No. MAIG_6278

Family Elateridae

25. *Baltelater bipectinatus* Kundrata *et al*., 2020 (Baltic amber, Sambia deposit); holotype, No. MAIG_6685

Family Endomychidae

26. *Cretostenotarsus striatus* Tomaszewska, Szawaryn *et* Arriaga-Varela, 2022, (Myanmar amber (burmite)); holotype, No. MAIG_5999
27. *Leiestes tomaszewskae* Alekseev *et* Bukejs, 2022, (Baltic amber, Sambia deposit); holotype, No. MAIG_6723

Family Erotylidae

28. *Zavaljus lyubarskyi* Alekseev *et* Bukejs, 2022 (Baltic amber, Rovno deposit); holotype, No. MAIG_6815

Family Eucnemidae

29. *Isorhipis muonai* Alekseev *et* Bukejs, 2022 (Baltic amber, Sambia deposit); holotype, No. MAIG_6811

Family Histeridae

30. *Acritus (Acritus) sutirca* Alekseev *et* Bukejs, 2021 (Baltic amber, Sambia deposit); holotype, No. MAIG_5541

Family Hydrophilidae

31. *Crenitis profechuyi* Arriaga-Varela, Brunke *et* Fikáček, 2019 (Baltic amber); holotype, No. MAIG_5954; paratypes No. MAIG_5950, No. MAIG_5951
32. *Helochares fog* Arriaga-Varela *et al.*, 2019 (Baltic amber); holotype, No. MAIG_6011

Family Limnichidae

33. *Platypelochares electricus* Hernando, Szawaryn *et* Ribera, 2018 (Baltic amber); holotype, No. MAIG_5948

Family Lycidae

34. *Damzenium rivnense* Kazantsev *et* Bocak, 2022 (Baltic amber, Rovno deposit); holotype, No. MAIG_6827
35. *Protolycus gedaniensis* Kazantsev, 2019 (Baltic amber); holotype, No. MAIG_6004

Family Melandryidae

36. *Madelinia capillata* Alekseev *et* Bukejs, 2021 (Baltic amber, Sambia deposit); holotype, No. MAIG_6708
37. *Madelinia gedanoposita* Alekseev *et* Pankowski, 2020 (Baltic amber); holotype, No. MAIG_6692
38. *Symphora pollocki* Alekseev *et* Bukejs, 2021 (Baltic amber, Sambia deposit); holotype, No. MAIG_6713

Family Melyridae

39. *Colotes sambicus* Kubisz, 2001 (Baltic amber); holotype, No. MAIG_3592

Family Monotomidae

40. *Rovnoeurops mckellari* Alekseev *et* Bukejs*,* 2022 (Baltic amber, Rovno deposit); holotype, No. MAIG_6814

Family Mordellidae

41. *Tomoxia succinea* Bao *et al.*, 2018 (Baltic amber); holotype, No. MAIG_5715; paratype, No. MAIG_5743

Family Mycteridae

42. *Europoeurypus inglaeso* Alekseev, Bukejs *et* Pollock, 2020 (Baltic amber, Sambia deposit); holotype, No. MAIG_6081

Family Nitidulidae

43. *Melipriopsis baltica* Kirejtshuk *et* Bukejs, 2023 (Baltic amber, Sambia deposit); holotype, No. MAIG_6897

Family Oedemeridae

44. *Oedemera (Oedemera) girulskii* Szawaryn, Sontag *et* Kubisz, 2021 (Baltic amber); holotype, No. MAIG_6785

Family Ptilodactylidae

45. *Ptilodactyla odnosum* Telnov *et al.,* 2022 (Baltic amber, Rovno deposit); holotype, No. MAIG_6710

Family Ptinidae

46. *Petalium bruteno* Alekseev *et* Bukejs, 2021 (Baltic amber, Sambia deposit); holotype, No. MAIG_6781, paratype, No. MAIG_6782
47. *Petalium widewuto* Alekseev *et* Bukejs, 2021 (Baltic amber, Sambia deposit); holotype, No. MAIG_6783
48. *Xyletinus (Xyletinus) lobanovi* Bukejs, Alekseev *et* Háva, 2021 (Baltic amber, Sambia deposit); holotype, No. MAIG_6711

Family Rhynchitidae

49. *Baltocar sontagae* BUKEJS *et* LEGALOV, 2021 (Baltic amber, Sambia deposit); holotype, No. MAIG_6703
50. *Pseudomesauletes (Pseudomesauletes) lobanovi* BUKEJS *et* LEGALOV, 2021 (Baltic amber, Sambia deposit); holotype,
No. MAIG_6701

Family Scarabaeidae

51. *Ataenius damzeni* BUKEJS *et* ALEKSEEV, 2018 (Baltic amber); holotype, No. MAIG_5953_1; paratype, No. MAIG_5953_2

Family Silvanidae

52. *Austronausibius aenigmatista* ALEKSEEV *et* BUKEJS, 2022 (Baltic amber, Rovno deposit); holotype, No. MAIG_6816
53. *Cathartosilvanus perkovskyi* ALEKSEEV *et* BUKEJS, 2021 (Baltic amber, Rovno deposit); holotype, No. MAIG_6784

Family Staphylinidae

54. *Atheta (Datomicra) jantarica* PAŚNIK, 2005 (Baltic amber); holotype, No. MAIG_589
55. *Baltioligota electrica* PAŚNIK, 2005 (Baltic amber); holotype, No. MAIG_4191
56. *Dictyon antiquus* PAŚNIK *et* KUBISZ, 2002 (Baltic amber); holotype, No. MAIG_1968
57. *Eusphalerum bukejsi* SHAVRIN, 2021 (Baltic amber, Sambia deposit); holotype, No. MAIG_6724
58. *Hemiquedius europaeus* BRUNKE, ŻYŁA *et* SOLODOVNIKOV, 2019 (Baltic amber); paratype, No. MAIG_4651
59. *Lathrobium jantaricum* PAŚNIK *et* KUBISZ, 2002 (Baltic amber); holotype, No. MAIG_1161
60. *Lathrobium succini* PAŚNIK *et* KUBISZ, 2002 (Baltic amber); holotype, No. MAIG_3232
61. *Paleosepedophiluscus succini* PAŚNIK *et* KUBISZ, 2002 (Baltic amber); holotype, No. MAIG_3079
62. *Phymatura electrica* PAŚNIK *et* KUBISZ, 2002 (Baltic amber); holotype, No. MAIG_296
63. *Tachyporus bicoloratus* PAŚNIK, 2005 (Baltic amber); holotype, No. MAIG_4184

Family Tenebrionidae

64. *Asiomira dubrovinae* NABOZHENKO *et* BUKEJS, 2021 (Baltic amber, Sambia deposit); holotype, No. MAIG_6806
65. *Eledonoprius incoronatus* ALEKSEEV *et* BUKEJS, 2020 (Baltic amber); holotype, No. MAIG_6012
66. *Isomira (Mucheimira) lobanovi* NABOZHENKO *et* BUKEJS, 2021 (Baltic amber, Sambia deposit); holotype, No. MAIG_6704
67. *Statira baltica* TELNOV *et al.*, 2019 (Baltic amber); holotype, No. MAIG_5982
68. *Wanachia pinisucciniferae* ALEKSEEV *et* BUKEJS*,* 2022 (Baltic amber, Sambia deposit); holotype, No. MAIG_6817

Family Tereddidae

69. *Teredolaemus primigenius* ALEKSEEV *et al*., 2021 (Baltic amber, Sambia deposit); holotype, No. MAIG_6805.

Family Tetratomidae

70. *Elasontagius dorbnickensis* ALEKSEEV *et* BUKEJS, 2020 (Baltic amber); holotype, No. MAIG_6702
71. *Eustrophus praecursor* ALEKSEEV *et* BUKEJS, 2022 (Baltic amber, Sambia deposit); holotype, No. MAIG_6819

Family Zopheridae

72. *Semicoxelus sontagae* ALEKSEEV *et* PANKOWSKI, 2020 (Baltic amber); holotype, No. MAIG_6693

Diptera

Family Anisopodidae

73. *Sylvicola hoffeinsorum* WOJTOŃ *et al.*, 2018 (Baltic amber); holotype, No. MAIG_773a

Family Ceratopogonidae

74. *Culicoides ellenbergeri* SZADZIEWSKI *et* DOMINIAK, 2019 (Burmese amber); holotype, No. MAIG_5666
75. *Forcipomyia (Lepidohelea) antilleana* SZADZIEWSKI *et* GROGAN, 1998 (Dominican amber); paratype, No. MAIG_26
76. *Forcipomyia rasnitsyni* SZADZIEWSKI, SONTAG *et* PANKOWSKI, 2021 (Ethiopian amber); holotype, No. MAIG_6697
77. *Leptoconops ellenbergeri* SZADZIEWSKI, 2014 (Burmese amber); holotype, No. MAIG_5613
78. *Mallochohelea martae* SZADZIEWSKI, 2005 (Baltic amber); holotype, No. MAIG_4901
79. *Metahelea serafini* SZADZIEWSKI, 1998 (Baltic amber); holotype, No. MAIG_111
80. *Meunierohelea fudalai* SZADZIEWSKI, SONTAG *et* BOJARSKI, 2020 (Dominican amber); holotype, No. MAIG_6267
81. *Stilobezzia dominicana* SZADZIEWSKI *et* GROGAN, 1998 (Dominican amber); holotype, No. MAIG_23

Family Chaoboridae

82. *Gedanoborus kerneggeri* Szadziewski *et* Giłka, 2007 (Baltic amber); holotype, No. MAIG_4995

Family Chironomidae

83. *Furcobuchonomyia pankowskii* Giłka *et* Zakrzewska, 2017 (Burmese amber); holotype, No. MAIG_5949
84. *Stempellinella electra* Giłka *et* Zakrzewska, 2015 (Baltic amber); holotype, No. MAIG_4295a
85. *Tanytarsus fereci* Giłka, 2011 (Baltic amber); holotype, No. MAIG_4356
86. *Tanytarsus glaesarius* Giłka *et* Zakrzewska, 2015 (Baltic amber); holotype, No. MAIG_415a
87. *Tanytarsus protogregarius* Giłka *et* Zakrzewska, 2015 (Baltic amber); holotype, No. MAIG_4325a; 2 paratypes, No. MAIG_4325a
88. *Tanytarsus serafini* Giłka, 2010 (Baltic amber); holotype, No. MAIG_5157; paratype, No. MAIG_5157

Family Corethrellidae

89. *Corethrella baltica* Borkent, 2008 (Baltic amber); holotype, No. MAIG_3613

Family Culicidae

90. *Coquillettidia adamowiczi* Szadziewski *et al.*, 2019 (Baltic amber); holotype, No. MAIG_5966
91. *Coquillettidia gedanica* Szadziewski *et al.*, 2019 (Baltic amber); holotype, No. MAIG_5663
92. *Ochlerotatus serafini* (Szadziewski, 1998) (Baltic amber); holotype, No. MAIG_112

Family Limoniidae

93. *Dicranomyia kalandyki* Krzemiński, 2000 (Baltic amber); holotype, No. MAIG_2123
94. *Helius fossilis* Kania, 2014 (Baltic amber); holotype, No. MAIG_587
95. *Helius gedanicus* Kania, 2014 (Baltic amber); holotype, No. MAIG_4073
96. *Helius similis* Kania, 2014 (Baltic amber); holotype, No. MAIG_3413

Family Mycetophilidae

97. *Allodia paleoafricana* Bouju *et al.,* 2021 (Ethiopian amber); holotype, No. MAIG_6017

Family Psychodidae

98. *Hoffeinsodes adamowiczi* Skibińska *et al.*, 2020 (Baltic amber); holotype, No. MAIG_5990
99. *Trichomyia (Trichomyia) fudalai* Azar, Pielowska-Ceranowska *et* Szwedo, (Dominican amber); holotype, No. MAIG_6769.2.
100. *Trichomyia (Septemtrichomyia) grimaldii* Azar, Pielowska-Ceranowska *et* Szwedo, (Dominican amber); holotype, No. MAIG_6769.1.

Family Ptychopteridae

101. *Neuseptychoptera carolinensis* Szadziewski, Krynicki *et* Krzemiński, 2017 (Upper Cretaceous amber of North Carolina); holotype, No. MAIG_5667

Family Scatopsidae

102. *Afroscatopse haennii* Szadziewski *et al.,* 2022 (Ethiopian amber); holotype, No. MAIG_ 6013

Family Tipulidae

103. *Tipula (Gedanica) adamowiczi* Krzemiński *et al.*, 2020 (Baltic amber); holotype, No. MAIG_5945

Ephemeroptera

Family Ephemerellidae

104. *Ephemerella trigonoptera* Staniczek *et al.*, 2017 (Baltic amber); holotype, No. MAIG_2658

Family Heptageniidae

105. *Burshtynogena fereci* Godunko *et* Sontag, 2004 (Baltic amber); holotype, No. MAIG_2182

Hemiptera

Family Aleyrodidae (Sternorrhyncha: Aleyrodoidea)

106. *Paernis gregorius* Drohojowska *et* Szwedo, 2011 (Baltic amber); holotype, No. MAIG_5418

Family Aphalaridae (Sternorrhyncha: Psylloidea)

107. *Eogyropsylla sedzimiri* Drohojowska, 2011 (Baltic amber); holotype, No. MAIG_1708

Family Cicadellidae (Typhlocybinae: Protodikraneurini; Cicadomorpha)

108. *Protodikraneura ferraria* Szwedo *et* Gębicki, 2008 (Baltic amber); holotype, No. MAIG_5136

Family Cixiidae

109. *Glisachaemus jonasdamzeni* Szwedo, 2007 (Baltic amber); holotype, No. MAIG_5075

Family Dictyopharidae (Worskaitini; Fulgoromorpha)

110. *Worskaito stenexi* Szwedo, 2008 (Baltic amber); holotype, No. MAIG_5277

Family Dinglidae (Sternorrhyncha; Dinglomorpha)

111. *Dingla shagria* Szwedo *et* Drohojowska, 2020; (Burmese amber); holotype, No. MAIG_5979, paratype, No. MAIG_5980

Family Issidae (Issinae: Issini; Fulgoromorpha)

112. *Thionia douglundbergi* Stroiński *et* Szwedo, 2008 (Dominican amber); holotype, No. MAIG_5278; paratype, No. MAIG_5279

Family Kuwaniidae (Sternorrhyncha: Coccidimorpha)

113. *Hoffeinsia foldii* Koteja, 2008 (Baltic amber); holotype and 2 paratypes, No. MAIG_1309

Family Liadopsyllidae (Sternorrhyncha: Psylloidea)

114. *Amecephala pusilla* Drohojowska *et al.*, 2020 (Burmese amber); holotype, No. MAIG_6686

Family Microphysidae (Heteroptera: Cimicomorpha)

115. *Loricula (Loricula) polonica* Popov *et* Herczek, 2008 (Baltic amber); holotype, No. MAIG_3115

Family Miridae (Heteroptera: Cimicomorpha)

116. *Isomyiomma hirta* Herczek*,* Popov *et* Drohojowska, 2020 (Baltic amber); holotype, No. MAIG_6279

Family Paraprotopsyllidiidae (Sternorrhyncha: Protopsyllidioidea)

117. *Maliawa akrawna* Drohojowska *et* Szwedo, 2020 (Burmese amber); holotype, No. MAIG_6689

Family Postopsyllidiidae (Sternorrhyncha: Protopsyllidioidea)

118. *Megalophthallidion burmapateron* Drohojowska *et* Szwedo, 2022 (Myanmar amber (burmite)); holotype, No. MAIG_6687

Family Tropiduchidae (Patollini; Fulgoromorpha)

119. *Gedanotropis sontagae* Szwedo *et* Stroiński, 2017 (Baltic amber); holotype, No. MAIG_6079 (508762)
120. *Patollo natangorum* Szwedo *et* Stroiński, 2013 (Baltic amber); holotype, No. MAIG_5419

Hymenoptera

Family Encyrtidae

121. *Eocencnemus gedanicus* Simutnik, 2014 (Baltic amber); holotype, No. MAIG_201
122. *Glaesus gibsoni* Simutnik, 2014 (Baltic amber); holotype, No. MAIG_477

Family Formicidae

123. *Desyopone hereon* Boudinot *et* Perrichot, 2022 (Ethiopian amber); holotype, 12 paratypes, No. MAIG_6016
124. *Stigmomyrmex rugulosus* Radchenko *et* Dlussky, 2017 (Baltic amber); holotype, No. MAIG_1995
125. *Technomyrmex svojtkai* Perrichot *et* Engel, 2022 (Ethiopian amber); paratype, No. MAIG_6020

Neuroptera

Family Coniopterygidae

126. *Hemisemidalis kulickae* Dobosz *et* Krzemiński, 2000 (Baltic amber); holotype, No. MAIG_1214

Odonata

Family Megapodagrionidae

127. *Electropodogrion szwedoi* Nel *et* Azar, 2008 (Baltic amber); holotype, No. MAIG_5050

Arachnida

Trombidiformes: Prostigmata: Erythraeidae

128. *Burphanolophus joergwunderlichi* Konikiewicz *et* Mąkol, 2018 (Burmese amber); holotype, No. MAIG_5932

Trombidiformes: Prostigmata: Microtrombidiidae

129. *Porttrombidium gedanense* Konikiewicz *et al.*, 2016 (Baltic amber); holotype, No. MAIG_1343; paratypes, No. MAIG_3048 and No. MAIG_896

Trombidiformes: Prostigmata: Smarididae

130. *Fessonia wunderlichi* Bartel *et al.*, 2015 (Baltic amber); holotype, No. MAIG_5649

Trombidiformes: Prostigmata: Tanaupodidae:

131. *Eothrombium fortesambiense* Mąkol *et al.*, 2018 (Baltic amber); holotype, No. MAIG_5963
132. *Propolyssenia wohltmanni* Mąkol *et al.*, 2018 (Baltic amber); holotype, No. MAIG_5961, paratype No. MAIG_5962

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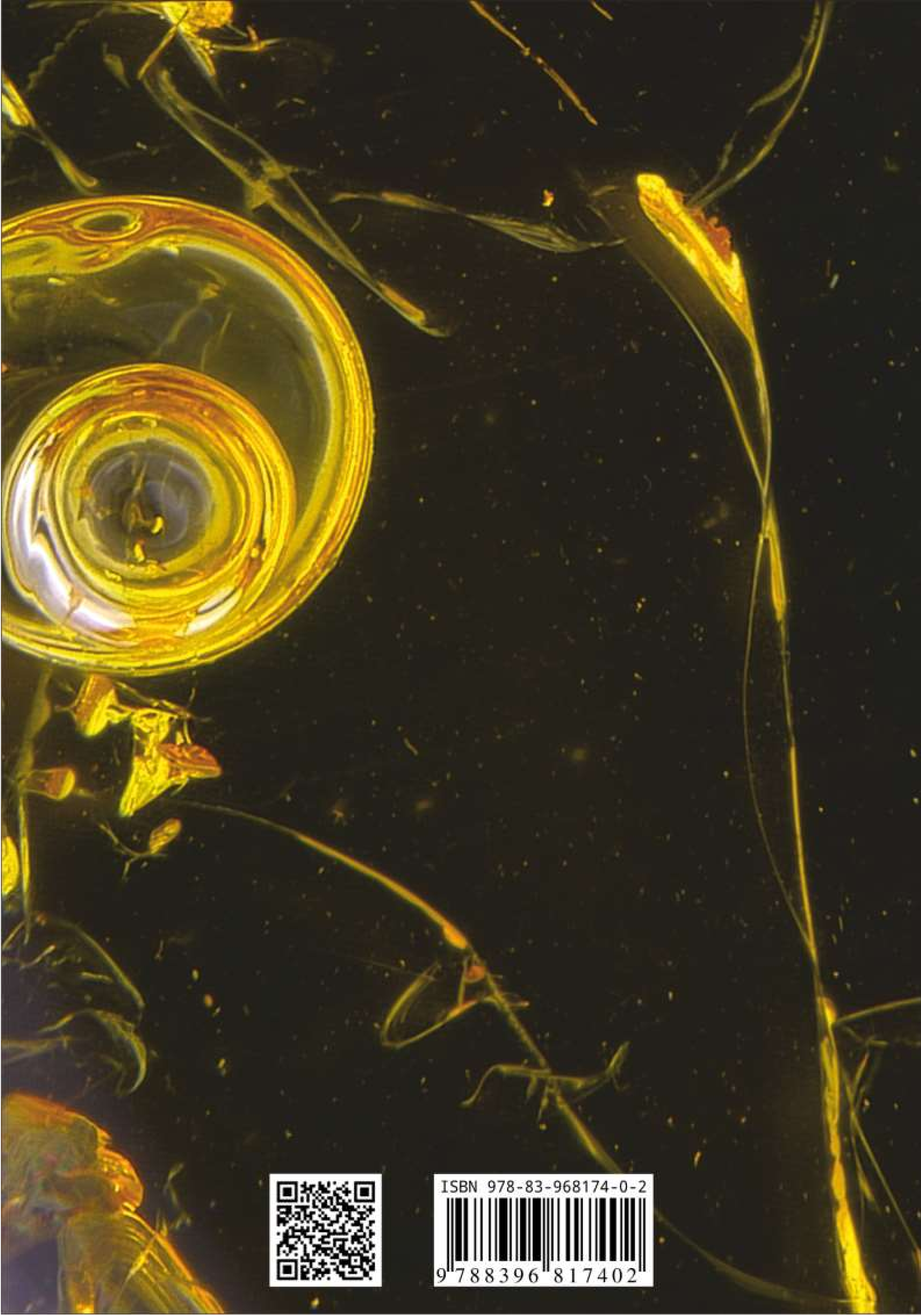

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