Unlike ordinary books and catalogues, where the arrangement is made according to countries, dates or subjects, in this book trilobites are arranged following the classification proposed by R. A. Fortey (1997) in the Treatise on invertebrate Palaeontology and followed by almost all palaeontologists. According to both this classification and the fact that authors found examples of all orders of trilobites, this part of the book is divided into nine chapters. The first eight focus on each of the accepted orders and the last chapter deals with both non-determinable trilobites and those stylised by designers of stamps and philatelic motifs.

The number of times the various orders of trilobites appear is highly variable. The order of Agnostida is only represented once. In contrast, the order of Phacopida, the most frequently found in Philately, shows twelve species; two of these twelve species, in open nomenclature, are included in the genera of *Phacops* and *Asteropyge* by the authors. Other orders have intermediate appearances: four different species for each order of Redlichiida and Corinexochida; six for Lichda and Proetida; and seven for the orders of Asaphida and Ptychopariida. Some of species appear more than once on different stamps and/or postmarks and other related philatelic stationary. Such is the case of *Olenoides serratus, P.(Pedinopariops) brongniarti, Selenopeltis buchi* and others.

Those stamps and postmarks featuring trilobites that either have not been classified or exhibit characteristics that do not fit any accepted species are found at the end of the systematics chapter. Neither these forms nor an extra form mentioned in the appendix, together with a warning about the danger of forgery in the market, will be considered here.

The philatelic reproduction of the trilobites agrees with the number of genera found in the fossil record that belong to each of the systems of the Palaeozoic. Thus, the best represented systems are the Cambrian and the Ordovician with 13 and 17 different species respectively featured in stamps, postmarks and other related philatelic material. Six species belong to the Silurian and another nine to the Devonian. It is important to notice the decrease in the number of forms in the Silurian during this period, when the fauna was recovering from the Great Extinction at the end of Ordovician. It is during the Devonian that trilobites recover their importance both in the fossil register and, nowadays, in philately. Finally, the Carboniferous and Permian systems are both represented by just one species. This shows the little opportunity trilobites had to diversify after the episodes of extinction, Kellwasser in the Upper Devonian and Hangenberg in the Devonian - Carboniferous boundary when a general decline ended with their extinction in the Late Permian.

The presentation of the philatelic material following the systematic arrangements employed in the Treatise on Invertebrate Palaeontology, together with photographs of the classified species and the wide and precise information given, distinguishes this book from other catalogues. For this reason, as the authors themselves state, this book is intended for those interested in fossils, trilobites in particular, and those interested in Philately, whether or not they are specialists.

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***Atlas of Plants and Animals in Baltic Amber.*** By W. WEITSCHAT and W. WICHARD (2002). Verlag Dr. Friedrich Pfeil, Munich (Germany). 256 pages, 92 color plates, 124 figures; 29 x 21.7 cm, hardcover; ISBN 3-931516-94-6; Euro 75,00, US$ 98.00.

When asked by people as to the nature of my employment, I often respond by saying that "I am a paleobiologist." Often the reaction is a quizzical look, after which I state that "paleobiology is the study of ancient life," Typically, I almost always receive some variation of the following comment: "Oh, then you must study dinosaurs, look at amber, or go on digs for artifacts." This usually is followed by my feeble attempt to relate paleobiology to their earlier comments, but I am always amazed by the pervasiveness of amber in the public consciousness amid discussions of fossils or premodern organisms. Whereas dinosaurs exert a fascination that is larger than life, it seems that amber represents another exceptional feature of the fossil record: namely, it is viewed as the epitome in fossil preservation and presentation. Interestingly, these two celebrated features of the fossil record—dinosaurs and amber—crossed paths several years ago in the popular movie *Jurassic Park*, and in spite of some inaccuracies on the screen, made an audience aware that the study of amber is a serious intellectual quest.

The task of presenting the science and wonder of amber has been greatly extended by coauthors Wolfgang Weitschat and Wilfried Wichard in an *Atlas of Plants and Animals in Baltic Amber*. The front and back endpapers are a prodromus: the front drawing presents a conspicuous kingfisher in the foreground, a tarsier-like primate in the middle distance, and faint outlines of tapirs browsing in the distant mist, all of which are surrounded by epiphytic bromeliads, ferns, clinging lianas and a generic conifer producing copious flows of resin as dragonflies, butterflies and other insects flit about. The back endpaper depicts a large, ominous and predaceous bird, a *Diatryma*, lurking amid palmettos in the background, as various insects dance above a water-lily pond and grassy glade, all of which are surrounded by the same resin-gushing and

moss-encrusted conifers. These backdrops are reinforced by the author's preface (p. 4), in which they state that, although their volume is an "interim report," they "…would like to provide readers with a well-researched standard reference that gives an informative and interesting overview of the plant and animal groups in Baltic amber on the basis of illustrations, photographs and accompanying texts." With some reservations regarding the latter, they accomplish their stated goals with diligence and grace. Their production represents an updated version that was translated from the German of an earlier volume published in 1998.

This is a volume that fills an important niche, in spite of a spate of recent books devoted to the scholarly and artistic illustration and discussion of amber and their inclusions. These books generally have focused on more recently discovered amber from the Dominican Republic (Poinar, 1992, 1999; Grimaldi, 1996). By contrast, volumes on Baltic amber—which represent the oldest scientifically known and continuously studied such deposit—are comparatively older. Book-length examples discussing and figuring Baltic amber originate from (1) the early monographic period of the 1800's and include the work of Presl, Berendt, Runge, Goeppert, Menge, and Conwentz, (2) syntheses of the middle last century (Ander, 1942; Bachofen-Echt, 1949; Andrée, 1951), and (3) a diverse array of accounts beginning during the late 1970's (Larsson, 1978; Schlee and Glöckner, 1978; Schlee, 1980, 1990; Krzeminska et al., 1992; Wichard and Weitschat, 1996). Given this historical precedence, the time was certainly ripe for a comprehensive, up-to-date English-language atlas of the inclusions in Baltic amber and a discussion of their significance. On balance, this is a very useful and well-produced book. However, the volume does present some omissions and difficulties, which involve two general issues. The first consists of general criticisms involving content, particulary the absence of relevant and recent research for updating certain text sections, errors of fact, and topics that should have been included.

As for sections that could have been illuminated by inclusion of the results from current research, one major absence was recent evidence indicating the taxonomic affinities of the amber producing tree (p. 13-16). Ignored was Langenheim's (1995) analysis, who favors an araucariaceous origin perhaps close to *Agathis*, and especially Anderson and LePage's (1995) study in the same volume, indicating a pinaceous source plant related or ancestral to golden larch (*Pseudolarix*). Both hypotheses contradict the historical view that the source tree was taxonomically proximal to or actually a *Pinus*. An additionally neglected topic was the entire subject of retrieving DNA from Baltic amber. The initial optimism of using insect DNA sequences to address phylogenetic hypotheses of insect evolution during the early 1990's was dashed later in the decade by the analyses and reviews of several researchers, who reported the irreproducibility of the original studies, including those of Baltic amber (Pawlowski et al., 1996; Austin et al., 1997). Their conclusion was that fossil resins are highly unlikely to preserve original DNA and that the spate of earlier reports purporting to demonstrate the presence of amber DNA millions to tens of millions of years old is attributable to modern contamination. Another absence is the section on paleoclimate of the Baltic amber forest (p. 22), which could have benefited from some modern references that have considerably refined the timing of the Early Cenozoic Thermal Maximum event (p. 27, 28). It has been known for several years that the peak of maximum temperature is significantly closer to the Paleocene/Eocene boundary (Wing et al., 1999; Wilf, 2000) than that displayed in fig. 18. Last, the statement that myriapods are the closest relatives of hexapods and that they constitute a monophyletic Tracheata (p. 82) is certainly at odds of virtually all molecular analyses of the recent past (Averof and Akam, 1995; Panganiban et al., 1995). These missed opportunities to set the record straight indicate that more attention should have been devoted toward consulting the more recent literature.

Factual errors occasionally dot the text. Perhaps the most glaring is the statement that "…the preservation and visibility of microstructures conserved in amber is unique in the field of paleontology" (p. 29). Such is not the case. It has been well established for more than 50 years that acetate peels of plants from many Carboniferous coal-ball deposits retain permineralized microstructure at the cellular and subcellular levels as well as the best preserved of amber fossils. For example, details such as trichome cell-wall construction and the surface ornamentation of spores are readily observable on microscope slides or SEM preparations of acetate peels (Millay, 1979). Interestingly, these same Late Carboniferous deposits contain the permineralized foliage of certain tree ferns (*Pecopteris*) and seed ferns (*Alethopteris*), which we find out also occur in Baltic amber (p. 40). This 250 million-year range for a foliage form-genus certainly must be *the* greatest record for longevity of any terrestrial plant! Undoubtedly such assignments have more to do with application of the form-genus concept than for any meaningful documentation lineage duration. Also noted were sundry misstatements such as coniferous reproductive structures which were referred to as "flowers" (p. 44) rather than cones or strobili; and the dating of the neuropterid insect *Juraconiopteryx* of Karatau, in Kazakhstan, as Upper Cretaceous (p. 144) when it should have been assigned to the Upper Jurassic (Meinander, 1975).

A few topics of broad evolutionary interest could have sparked additional interest in the Baltic amber biota. The authors state that "…the composition of the flora and fauna preserved in Baltic amber is a 'curious mixture of tem-

perate, subtropical and tropical life forms'" (p. 38) and that it is most closely related to Southeast Asia (p. 72), an observation that is mentioned repeatedly in the ensuing text. A more explicit, process-oriented discussion of why the overwhelming biogeographical affinities are with the Southeast Asian biota would have been rewarding, especially one that involved consideration of the climatic history and tectonic movements of Cenozoic Eurasia and its constituent continental fragments. Also warranted would have been a section discussing the evolutionary longevity of insect and other taxa at lower taxonomic levels, particularly extant genera and presumably species. This surprising feature of the Baltic amber biota has been commented on by various authors (Klyuge, 1986; Röschmann, 1999), and is particularly striking when compared to the vast disparities in taxonomic rank for analogous vertebrate faunas spanning the same time interval (Labandeira and Sepkoski, 1993). Finally, in the context of the diversity of the insect fauna, a separate section should have been devoted to those taxa that were first found as Baltic amber fossils, and later discovered to be extant, such as the false click beetle *Electribius* (Lawrence, 1995) the net winged beetle *Kolibaceum* (Kasantsev, 1997) which were not mentioned, and *Raptophasma*, and the first discovered member of the new order Mantophasmatodea which was cited in passing (p. 110) (Klass et al., 2002). Undoubtedly there are other Baltic amber taxa that await discovery in the Recent, which may be a testament to how better known this Lagerstätten is relative to many relatively unexplored regions of the modern world. Lastly, mention of the presence of proturans is tantalizing (p. 83), particularly as the Protura are the only major hexapod clade that supposedly lack a fossil record. A section and photographic documentation devoted to this group would have been most welcome.

My second group of criticisms are more particular, and concerns peccadilloes such as oversights in translation of the German to accessible English, confusions in entomological and botanical terminology, the presence of awkward syntax, inconsistencies between figures and their labels, and incorrect author names in the references. Much more care should have been exercised by the translators and editors in the catching these errors, especially avoiding the rendering of German into stilted or otherwise stodgy English. Improper renderings of German into English, for example, resulted in factual difficulties, such as conflation of the verbs "diversify" and "diverge" in the passage "…in the Late Mesozoic and early Cenozoic, when the angiosperms and gymnosperms (specifically the conifers) diverged" (p. 10), when in fact the ancestors of these two seed-plant clades diverged significantly earlier during the Paleozoic (Stewart and Rothwell, 1993). Other examples include the replacement of "utterly" by "entirely" in "The paleogeographical situation changed utterly once again in the Neogene" (p. 17); the somewhat humorous "principle of actuality" (p. 37) instead of the "principle of actualism," which is part of the broader concept of uniformitarianism as a way of understanding the past; the substitution of "lightning strokes" for "lightning strikes" (p. 46); "spinner" for "spinneret" (p. 76); and "coverts" rather than "coverlets" (p. 220) to describe a type of feather.

More of a nuisance, at least to a North American entomological audience, are unconventional uses of entomological terminology. The most confusing example is use of the terms "larva" and "nymph" in the context of holometabolous and nonholometabolous insects. In North America the term larva is restricted to holometabolous insects; the immatures of nonholometabolous insects are termed "nymphs" if terrestrial, or if aquatic, the designation "naiad" is frequently used (China, 1958; Davies, 1958). These distinctions—the European (Sehnal et al., 1996) and the North American (Truman and Riddiford, 2002)—survive to the present day. Although comprehensible to an European audience, I was content to learn that subadult cockroaches are nymphs (p. 106) but surprised to be informed that subadult earwigs are larvae (p. 102). A short explanation of the European and North American usage of the term, larva, would have been helpful. A second confusion is the lack of a distinction between a parasite and parasitoid. On page 36, roundworms of the family Mermithidae are deemed (endo)parasites even though they eventually cause the insect host's death—an essential feature of being a parasitoid (Godfray, 1994). Similarly almost all chalcidoid and chrysidoid wasps (p. 174, 176) and many strepsipterans (p. 170) were claimed to be parasites whereas they are parasitoids that kill their arthropod hosts toward the end of their life cycle.

A favorite entomological diversion is tracking the lack of common-name equivalents of insect taxa across languages and in the scientific literature. Perhaps the authors should not be faulted for this, but there are some glaring bloopers in the text. For example, the substitution of "lung snails" for "pulmonate snails" (p. 54) sounds like a newfound respiratory condition for vertebrates; as to "seed shrimps" for "ostracods" (p. 80), the former term was unknown to our resident ostracodologist; "walking leaves" are properly termed "leaf insects" (p. 110); the common name for a corixid (p. 118) is a water boatman; on page 206 several dipteran families do have widely known common names, such as hover flies for Syrphidae, soldier flies for Stratiomyiidae, and wormlions for Vermelionidae; and the authors repeat the very common mistake of designating the Drosophilidae as fruit flies when in fact they are pomace flies and it is the Tephritidae that are appropriately termed fruit flies. Finally, the oribatid mite genus *Liodes* is assigned to the family Liodidae, not Oribatidae.

There were an unacceptable number of passages where the meaning was not clear because of imperfect sentence

structure. A mistake repeated from previously cited literature was the quote that amber consists of "…natural fossil resins that are 'several million years old'" (p. 9), implying that amber can not be older than this, when what is meant is that amber is older than several million years in age. Another awkward construction is the sentence "The distribution ranges of the Anapidae and Archaeidae are similarly indifferent" (p. 72), suggesting a human emotional attribute to the biogeographical pattern of a taxon. Also, there is a lack of distinction in referring to deposits of allochthonous amber as involving *cycles* of deposition, as in the enigmatic phrase "…Lower Miocene sediments" occurring in their "third deposit" (p. 104).

Minor nuisances from the text include misspellings, problems associating figure captions with their respective illustrations, and a final check of the references for mistakes. Misspellings include "Glassata" for "Glossata" with reference to a higher-level lepidopteran taxon (p. 196), "monophylety" for "monophyly" (p. 210), and the lizard genus *Knemidophorus* which should have been *Cnemidophorus* (p. 218). Problems with figures and their captions begin with a general complaint regarding the frequent absence of designations of either "Baltic amber" or "Recent" to contextualize line drawings of organisms in Section 2; the labels of "ventral" and "dorsal" for views of Figure 19a and 19b, respectively, although they instead are right-lateral and left-lateral (p. 30); and the reference to *Raptophasma kerneggeri* as Plate 63f (p. 110), which should be Plate 36f. As for the references, problems occurred principally with the spelling of author's names, including Jablokov-Chnzorjan (p. 232), which should have been transliterated as Iablokoff-Khnzorian, Uhmann was misspelled as Uhnann (p. 243), and Szadziewski (p. 242) was also entered as Zadziewski (p. 245). Lastly, a subject index should have been included.

These textual deficiencies notwithstanding, the widespread appeal and applicability of this book is very evident. It is the best reference on Baltic amber that adequately (and impressively!) illustrates the variety of its inclusions, and assembles a reasonably timely and topical review of the relevant literature. There are many well-researched sections in this volume, including discussions of the nature of sedimentary recycling and the occurrence of Baltic amber in successively younger deposits (p. 10); taxonomic and taphonomic biases of organisms that involve microhabitat, size, behavior, and seasonality of resin production (p. 33-35); and the potential for host-specific insects (p. 164, 166) in elucidating the botanical composition of the amber forest. Given the high constructional quality of the book, it is modestly priced at Euro 75,00 or $US 98.00, and certainly is worth the price. This volume not only should grace coffee tables, but more importantly belongs on the desk of every researcher interested in terrestrial arthropod fossil history, insect evolution, or the variety of life in one of the fossil world's best-preserved ecosystems.

## References


Ander, K. 1942. Die Insektenfauna des baltischen Bernsteins nebst damit verknüpften zoogeographischen Problemen. Lunds Universitets Årsskrift, N.F., 38, 82 p.

Anderson, K.B., LePage, B.A., 1995. Analysis of fossil resins from Axel Heiberg Island, Canadian Arctic. American Chemical Society Symposium Series, 617: 170-192.

Andrée, K. 1951. Der Bernstein: Das Bernsteinland und sein Leben. Kosmos, Stuttgart, 96 p.

Austin, J., Ross, A.J., Smith, A.B., Fortey, R.A., Thomas, R.H., 1997. Problems of reproducibility—does geologically ancient DNA survive in amber-preserved insects? Proceedings of the Royal Society of London (B), 264: 467-474.

Averof, M., Akam, M., 1995. Insect-crustacean relationships: Insights from comparative developmental and molecular studies. Philosophical Transactions of the Royal Society of London (B), 347: 293-303.

Bachofen-Echt, 1949. Der Bernstein und seine Einschlüsse. Springer, Vienna, 204 p.

China, W.E., Henson, H., Hobby, B.M., Hinton, H.E., Macan, T.T., Richards, O.W., Wigglesworth, V.B., 1958. The terms "larva" and "nymph" in entomology. Transactions of the Society for British Entomology, 13: 17-24.

Davies, D.R. 1958. The terminology of the juvenile phases of insects. Transactions of the Society for British Entomology, 13: 25-36.

Godfray, H.C.J. 1994. Parasitoids: Behavioral and Evolutionary Ecology. Princeton University Press, Princeton, New Jersey, 473 p.

Grimaldi, D.A. 1996. Amber: Window to the Past. Abrams, New York, 216 p.

Kasantsev, S. 1997. A recent species of the fossil genus *Kolibaceum* Winkler (Coleoptera, Lycidae) from eastern China. Entomologica Basiliensia, 20: 159-164.

Klass, K.-D., Zompro, O., Kristensen, N.P., Adis, J., 2002. Mantophasmatodea: A new insect order with extant members in the Afrotropics. Science, 296: 1456-1459.

Klyuge, N.Y. 1986. A recent mayfly species (Ephemeroptera, Heptageniidae) in Baltic amber. Paleontological Journal, 20: 106-107.

Krzeminska, E., Krzeminski, W., Haenni, J.-P., Dufour, C., 1992. Les Fantomes de l'Ambre: Insectes Fossiles dans l'Ambre de la Baltique. Musée d'Histoire Naturelle de Neuchâtel, Switzerland, 142 p.

Labandeira, C.C., Sepkoski, Jr. J.J., 1993. Insect diversity in the fossil record. Science, 261: 310-315.

Langenheim, J.H. 1995. Biology of amber-producing trees: focus on case studies of *Hymenaea* and *Agathis*. American Chemical Society Symposium Series, 617: 1-31.

Larsson, S.G. 1978. Baltic amber—a palaeobiological study. Entomonograph, 1, 192 p.

Lawrence, J.F. 1995. *Electribius* Crowson: alive and well in

Mesoamerica, with notes on *Ctesibius* Champion and the classification of Artematopodidae. In J. Pakaluk and S.A. Slipinski, (eds.), Biology, Phylogeny, and Classification of Coleoptera: Papers Celebrating the 80th Birthday of Roy A. Crowson, pp. 411-431. Museum and Zoological Institute of the Polish Academy of Sciences, Warsaw.

Meinander, M. 1975. Fossil Coniopterygidae (Neuroptera). Notulae Entomologicae, 60: 53-57.

Millay, M.A. 1979. Studies of Paleozoic marattialeans: a monograph of the American species of *Scolecopteris*. Palaeontographica (B), 169: 1-69.

Panganiban, G., Sebring, A., Nagy, L., Carroll, S., 1995. The development of crustacean limbs and the evolution of arthropods. Science, 270: 1363-1366.

Pawlowski, J., Kmieciak, D., Szadziewski, R., Burkiewicz, A., 1996. Attempted isolation of DNA from insects embedded in Baltic amber. Inclusion, 22: 12-13.

Poinar, G.O., Jr. 1992. Life in Amber. Stanford University Press, Stanford, California, 350 p.

Poinar, G.O., Poinar, Jr. R., 1999. The Amber Forest: A Reconstruction of a Vanished World. Princeton University Press, Princeton, New Jersey, 239 p.

Röschmann, F. 1999. Revision of the evidence of *Tetracha carolina* (Coleoptera, Cicindelidae) in Baltic amber (Eocene-Oligocene). Estudios del Museo de Ciencias Naturales de Alava, 14: 205-209.

Schlee, D. 1980. Bernstein-Raritäten—Farben, Strukturen, Fossilien, Handwerk. Staatlichen Museums für Naturkunde in Stuttgart, 90 p.

Schlee, D. 1990. Das Bernstein-Kabinett—Begleitheft zur Bernsteinausstellung im Museum am Löwentor, Stuttgart. Stuttgarter Beitrage zur Naturkunde (C), 28, 100 p.

Schlee, D., Glöckner, W., 1978. Bernstein—Bernsteine und Bernstein-Fossilien. Stuttgarter Beitrage zur Naturkunde (C), 8, 72 p.

Sehnal, F., P. Švácha, Zrzavý, J., 1996. Evolution of insect metamorphosis. In: Gilbert, L.I., Tata, J.R., Atkinson, B.G. (eds.). Metamorphosis: Postembryonic Reprogramming of Gene Expression in Amphibian and Insect Cells, pp. 3-58. Academic Press, San Diego.

Stewart, W.N., Rothwell, G.W., 1993. Paleobotany and the Evolution of Plants. Second Edition. Cambridge University Press, Cambridge, U.K., 521 p.

Truman, J.W., Riddiford, L.M., 2002. Endocrine insights into the evolution of metamorphosis in insects. Annual Review of Entomology, 47: 467-500.

Weitschat, W., Wichard, W., 1998. Atlas der Pflanzen und Tiere im Baltischen Bernstein. Verlag Friedrich Pfeil, Munich, 256 p.

Wichard, W., Weitschat, W., 1996. Wasserinsekten im Bernstein: eine paläobiologische Studie. Entomologische Mitteilunge aus dem Löbbecke Museum & Aquazoo, 4, 121 p.

Wilf, P. 2000. Late Paleocene–early Eocene climate changes in southwestern Wyoming: Paleobotanical analysis. Geological Society of America Bulletin, 112: 292-307.

Wing, S.L., Bao, H., Koch, P.L., 1999. An early Eocene cool period?. Evidence for continental cooling during the warmest part of the Cenozoic. In: Huber, B.T., MacLeod, K., Wing, S.L. (eds.). Warm Climates in Earth History, pp. 197-237. Cambridge University Press, Cambridge, U.K.

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