An overview of Fulgoromorpha and Cicadomorpha in East African copal (Hemiptera)

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Abstract

East African copal is rich in inclusions, which normally do not occur single, but the number of species described from East African copal is relatively low. Inclusions of Fulgoromorpha and Cicadomorpha (Hemiptera) in East African copal are not very frequently mentioned. The age of this fossil resin – copal – is still uncertain, it may come from the Pliocene, but is generally regarded as Pleistocene (1-5 Ma).

Key words: Hemiptera, Fulgoromorpha, Cicadomorpha, Ricaniidae, Derbidae, Issidae, Cicadidae, copal, East Africa, Pleistocene.

Denisia 04,
zugleich Kataloge des OÖ. Landesmuseums,
Neue Folge Nr. 176 (2002), 57-66

Introduction

Planthoppers – Fulgoromorpha, and Cicadomorpha – treehoppers, frog-hoppers, cicadas and leafhoppers – are hemipterans common in almost all habitats throughout the world. It is estimated that more than 43.000 species of Fulgoromorpha and Cicadomorpha have been described (OMAN & SAILER 1986).

The fossil record of the representatives of these hemipteran lineages reaches the end of the Early Permian (SHCHERBAKOV 1996, 2000). The oldest resin inclusions of these insects come from Lower Cretaceous Lebanon amber (FENNAH 1987). Two species of planthoppers are known from Late Cretaceous Burmese amber (COCKERELL 1917). Representatives of both Fulgoromorpha and Cicadomorpha lineages are quite common in Eocene Baltic amber inclusions (SZWEDO & KULICKA 1999). The first description of representatives of this family from Baltic amber comes from the second half of the 19th century (GERMAR & BERENDT 1856), later followed by BERVOETS (1910), COCKERELL (1910), JACOBI (1938), USINGER (1939), EMELJANOV (1990, 1994), GĘBICKI & SZWEDO (2000a, b), and SZWEDO & GĘBICKI (1998, 1999, 2000). In a piece of Bitterfeld amber from Germany, dated Miocene but recently regarded as redeposited and believed to be of Eocene age (WEITSCHAT 1997), a few inclusions were found, but not yet formally described. From Oligocene/Miocene New World resins a few representatives planthoppers and leafhoppers have been mentioned (FENNAH 1963, GĘBICKI & WEGIEREK 1993, DIETRICH & VEGA 1995, SZWEDO 2000a, STROIŃSKI & SZWEDO 2000, EMELJANOV & SHCHERBAKOV 2000, SZWEDO & STROIŃSKI 2001).

1. Copal – fossil resin and its significance

Fossil, subfossil and recent resins, including these known as copal and amber, are widespread throughout the world. The word 'copal' is derived from Mexican Spanish, from Nahuatl word 'copalli' (RICE 1987, AHD 2000). There is some confusion concerning the term, because it is sometimes used to refer to any resin formed by tropical legume trees and the araucarians, as well to any subfossil resins, or to all fossil resins except Baltic amber. 'Copal' is sometimes used in place of 'resin', both for recent 'copal' and for fossil or subfossil 'copal', i.e. older than Pleistocene (SCHLÜTER & von GNIELINSKI 1987). According to SCHLEE (1984, 1990), the term 'copal' is also used for resins younger than 250 years! On the other hand, purists reserve this name for the resin of Caesalpiniaceae (GEIRNAERT 1998). Regarding the stratigraphic position of resins called 'copals', it seems that – in spite of all these nomenclature uncertainties and the lack of a strict definition of copal – the term refers to subfossil resins originating from the Southern Hemisphere and of Pleistocene age (1.64-5.2 Ma).

Where are these subfossil resins located? Most subfossil resins occur in tropics or very wet temperate areas, where the trees producing resin are still present. A single geographical region may have copal deposits of various ages, ranging from recent to many thousands years old.

On North Island of New Zealand the resin was and continues to be exuded from the Araucariaceae species *Agathis australis* – the Kauri pine. This resin is also called 'Kauri gum'. The stratigraphic age of this resin is obscure (SCHLÜTER & VON GNIELINSKI 1987). During the Mesozoic, Araucariaceae were common throughout the Northern Hemisphere, but disappeared in the Early Tertiary, so the recent distribution is now restricted to the Southern Hemisphere. The age of Kauri copal ranges from at least the Eocene up to the present (THOMAS 1968, SCHLÜTER 1978). This kind of resin is also known from Australia (HILLS 1957) and the Philippines (DURHAM 1956).

Fossil resin has also been reported from Indonesia (DURHAM 1956), probably originating from a tree of the family Dipterocarpaceae, and dated Upper Miocene – Sumatra localities, or Pliocene – Java localities (SCHLÜTER & VON GNIELINSKI 1987). Moreover, fossil resins with inclusions have been reported from Celebes (KLEINE 1924, who described fossil Coleoptera: Scolytidae) and from the Lower-Mid Miocene of the Sarawak Province in Malesia (HILLMER, VOIGT & WEITSCHAT 1992).

So called "Mizunami amber" is recorded from Japan. It was supposed to date back to the Middle Pleistocene, but according to radiometric data it is much younger, only about 33 000 (-1600 to +2000) years old (SCHLEE 1984).

From Israel another fossil resin has been recorded. It is probably of Pleistocene age and originates from *Pistacia lentisculus* tree, of the family Anacardiaceae (SCHLÜTER & VON GNIELINSKI 1987).

Most copals derive from leguminous (Fabales) trees of the family Caesalpiniaceae, particularly of the genus *Hymenaea*. Copal occurs in Central and South America: Minais Gerais Province in Brazil, Mariquita Province in Colombia and eastern Dominican Republic. It is sold to the collectors as "Pliocene amber", about 2 Ma old, but in fact it is merely several hundreds years old (GRIMALDI 1996).

A tree of the genus *Hymenaea* is also present in Africa, it is *Hymenaea verrucosa* regarded as a member of the primitive section *Trachylobium*, and restricted to East Africa and adjacent islands (POINAR 1992). This tree grows in lowland evergreen and semi-deciduous forests. HUEBER & LANGEHEIM (1986) suggest that the section *Trachylobium* is of African origin, and that *Hymenaea verrucosa* is a relict of the former Pan-African distribution.

Other African resins have been recorded from West Africa: Guinea, Sierra Leone, Ghana, Benin, Gabon, Congo and North East Angola (SCHLÜTER & VON GNIELINSKI 1987, RICE 1987). These resins originate from another Caesalpiniaceae (Fabales) tree of the genus *Copaifera*, with the estimated age ranging from the Pleistocene to 8000 years B.C. (SCHLÜTER & VON GNIELINSKI 1987). It is interesting, that only four species of *Copaifera* occur in West Africa, and most of them in South America, particularly in Brazil (LANGEHEIM 1973).

Copal from *Hymenaea verrucosa* – 'Mandrorofo' in the Malgaskan language – has also been reported from Madagascar (GEIRNAERT 1998).

The present existence and distribution of related resin-producing trees of the genera *Hymenaea* and *Copaifera* suggest that these genera, and probably also other Caesalpiniaceae, originated during the Early Cretaceous on the joined South American-African landmass. After the separation of the continents, they were subject to individual evolutionary processes based on genetic changes and environmental selection (POINAR 1992).

The East Coast of Africa (southern parts of Kenya and Tanzania) is one of the seven plant species endemism and richness areas in sub-Saharan Africa (LINDER 2001). An analysis of the inclusions of living organisms found in fossil and subfossil resins originating from the trees of this area is very important. Comparison between recent fauna and fossil organisms could help in description of life-histories of the insects as well as other animals and plants. Detailed analysis of the characters found in fossil representatives of the groups will advance the search of the origins and polarization of characters used in cladistic analyses.

2. Inclusions in East African copal

Most descriptions of inclusions in fossil resins come from Eocene Baltic amber and Oligocene/Miocene Dominican and Mexican amber. The specimens stored in the Natural History Museum London, labeled 'amber' and shown as amber in the Quarterly Journal of Science in 1868 are actually East African copal (ROSS 1999). Also the American Museum of Natural History has an extensive collection of insects preserved in East African copal (GRIMALDI 1996). Also copal from Madagascar is rich in inclusions (Geinaert, personal communication).

Generally, copal inclusions have rarely been described, although East African copal seems to be the source of relatively high number of taxa described (SCHLÜTER & VON GNIELINSKI 1987).

Among the groups mentioned from East African copal are: Araneae, Scorpionida, Blattodea, Isoptera, Embioptera, Psocoptera, Hemiptera, Coleoptera, Hymenoptera, Lepidoptera, Diptera and Reptilia. A sole species of Hemiptera: Cicadomorpha – *Cicada forsythi* BUCKT. has been described by Buckton (BUCKTON 1890, 1891).

Fulgoromorpha

The Fulgoromorpha, commonly named planthoppers are a group of about 12.000 described species, placed in 20 families. The representatives of this lineage are distributed universally, but mainly in the tropical and subtropical zones. Fulgoromorpha have a fossil record that can be traced to the uppermost Lower Permian. They are relatively frequent in fossil record, both imprints and fossil resins.

Until now, no species have been described from East African copal. In the material available to the authors, the following families were identified: Derbidae, Issidae and Ricaniidae. In the copal from Madagascar, also Flatidae and Nogodinidae were found, but unfortunately these specimens were not available to study yet. In the examined material, the most numerous were representatives of Ricaniidae, 7 specimens from the collection of the Natural History Museum, London [BMNH], and one specimen from the collection of Naturhistorisches Museum, Wien [NHMW].

Fig. 1:
***Acroprivesa msandarusi* sp. nov.**

Family Ricaniidae

Genus *Acroprivesa* SCHMIDT 1912

Type-species: *Acroprivesa suturalis* SCHMIDT 1912: 78

***Acroprivesa msandarusi* sp. nov. (Fig. 1)**

Etymology. Species name from the Suahili word 'msandarusi' – gum copal tree (*Hymenaea verrucosa*).

Terra typica. East coast of Tanzania.

Diagnosis. *Acroprivesa msandarusi* sp. nov. is similar to A. *suturalis* SCHMIDT 1912 but differs in the lateral carinae of frons (connected with median carina under the base, separated in A. *suturalis*), and the venation of tegmina (M_1 and M_2 leaving basal cell as separeted stems).

Description. Total length 9.7 mm. Vertex, without median carina, anteriad about 6.16 times as broad as long in mid line; anterior and posterior margin arcuate and parallel; lateral margins straight and subparallel.

Frons tricarinate 1.2 times broader at upper margin than long in mid line, widest at the level of ocelli and 1.51 times as wide as its length in mid line. Median carina extending almost to clypeal suture; lateral carinae connected with median under the base, reaching to the middle of frons. Upper margin almost straight, lateral arcuate. Clypeus with-

out median carina, clypeal suture almost straight.

Rostrum reaching hind coxae.

Pronotum, with median carina, 1.83 times as long as vertex in mid line; anterior margin widely arcuate, in median portion almost straight; posterior margin arcuate, in median portion a little concave.

Mesonotum 1.06 times as long as wide and 3.94 times longer than the cumulative length of vertex and pronotum in mid line; carinae of mesonotum invisible.

Tegmina elongate 1.9 times as long as wide. Costal margin slightly curved basally, in the median portion straight, the apical angle rounded; sutural margin forming re-entrant angle of 150° at apex of clavus; apical margin arcuate.

Costal membrane at the level of basal cell twice as wide as costal cell; at the median part 1.5 times wider. Costal membrane with dense transverse veinlets, costal cell without transverse veinlets. Basal cell 1.66 times as long as wide. Veins Sc+R leaving basal cell with common stem; M1 and M2 leaving basal cell separately. The ratio of stem lengths Sc+R:M1:M2:Cu on the left tegmen 1:2.64:1.4:3. Tegmina with 2 transverse lines and straight, irregular nodal line; apical and subapical cells longer than wide, subapical shorter than apical.

Clavus without transverse veinlets, veins A_1 and A_2 invisible.

Hind wing. Precostal cell 26 times longer than wide RA-RP and RP-MA_1 connected by single transverse vein.

Hind tibia with 2 lateral and 6 apical spines, first tarsomere with 6 apical spines, 1.35 times longer than the cumulative length of the second and third.

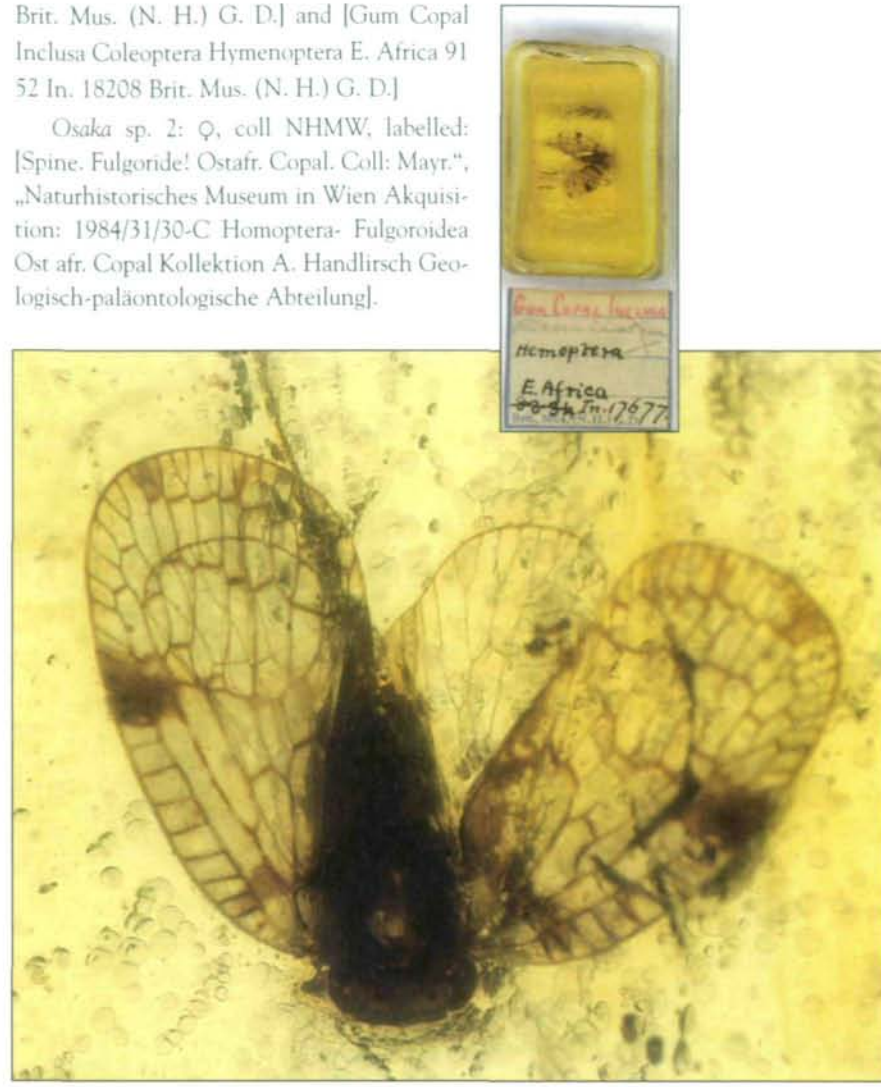
Other specimens belong to described recent genera, but without a systematic revision (A. Stroiński, in prep.) their proper identification and description are impossible

Genus *Osaka* Distant 1917

Type-species: *Osaka hyalina* Distant 1909: 44; pl. 4; figs. 15, 15a

Osaka sp. 1 (Figs. 2-3): two ♀♀, coll. BMNH, labelled: [Gum Copal Inclusa Ricaniidae Hemoptera E. Africa 88 34 In. 17677. Brit. Mus. (N. H.) G. D.] and [Gum Copal Inclusa Coleoptera Hymenoptera E. Africa 91 52 In. 18208 Brit. Mus. (N. H.) G. D.]

Osaka sp. 2: ♀, coll NHMW, labelled: [Spine. Fulgoride! Ostafr. Copal. Coll: Mayr.", „Naturhistorisches Museum in Wien Akquisition: 1984/31/30-C Homoptera- Fulgoroidea Ost afr. Copal Kollektion A. Handlirsch Geologisch-paläontologische Abteilung].



Figs. 2-3:
***Osaka* sp. 1. (2) specimen on slide ; (3) dorsal view.**

Genus *Pochazoides* Signoret 1860

Type-species: *Pochazoides maculatus* Signoret 1860: 193; pl. 5, figs. 6, 6a.

Pochazoides sp. 1: ♂, coll. BMNH, labelled: [Gum Copal Inclusa Stettin on Baltic 58572 Brit. Mus. (H. H.) G. D.].

Pochazoides sp. 2: ♀, coll. BMNH, labelled: [Formn. Pleistocene Copal Locy. Probably east coast of mainland facing Zanzibar. Colld. Luke Thomas and presd. Col. M. Burrows, Aug. 1945. Brit. Mus. Geol. Dept. In 38981.].

Genus *Pocharica* Signoret 1860

Type-species: *Pocharica ocellata* Signoret 1860: 192, pl. 5, figs. 5, 5a-b.

Pocharica sp. 1: sex indet., coll. BMNH, labelled: [Gum Copal Inclusa Ricaniidae Homoptera E. Africa 83 34 In. 17674. Brit. Mus. (N. H.) G. D.].

Indeterminate genus

A single specimen, coll. BMNH, labelled: [Formn. Pleistocene Copal Locy. Probably east coast of mainland facing Zanzibar. Colld. Luke Thomas and presd. Col. H. Burrows, Aug. 1945. Brit. Mus. Geol. Dept. In. 38928].

Family Derbidae

Genus *Zoraida* KIRKALDY 1900

Type-species: *Derbe sinuosa* BOHEMAN 1837: 225, pl. VII, figs. 1, 2

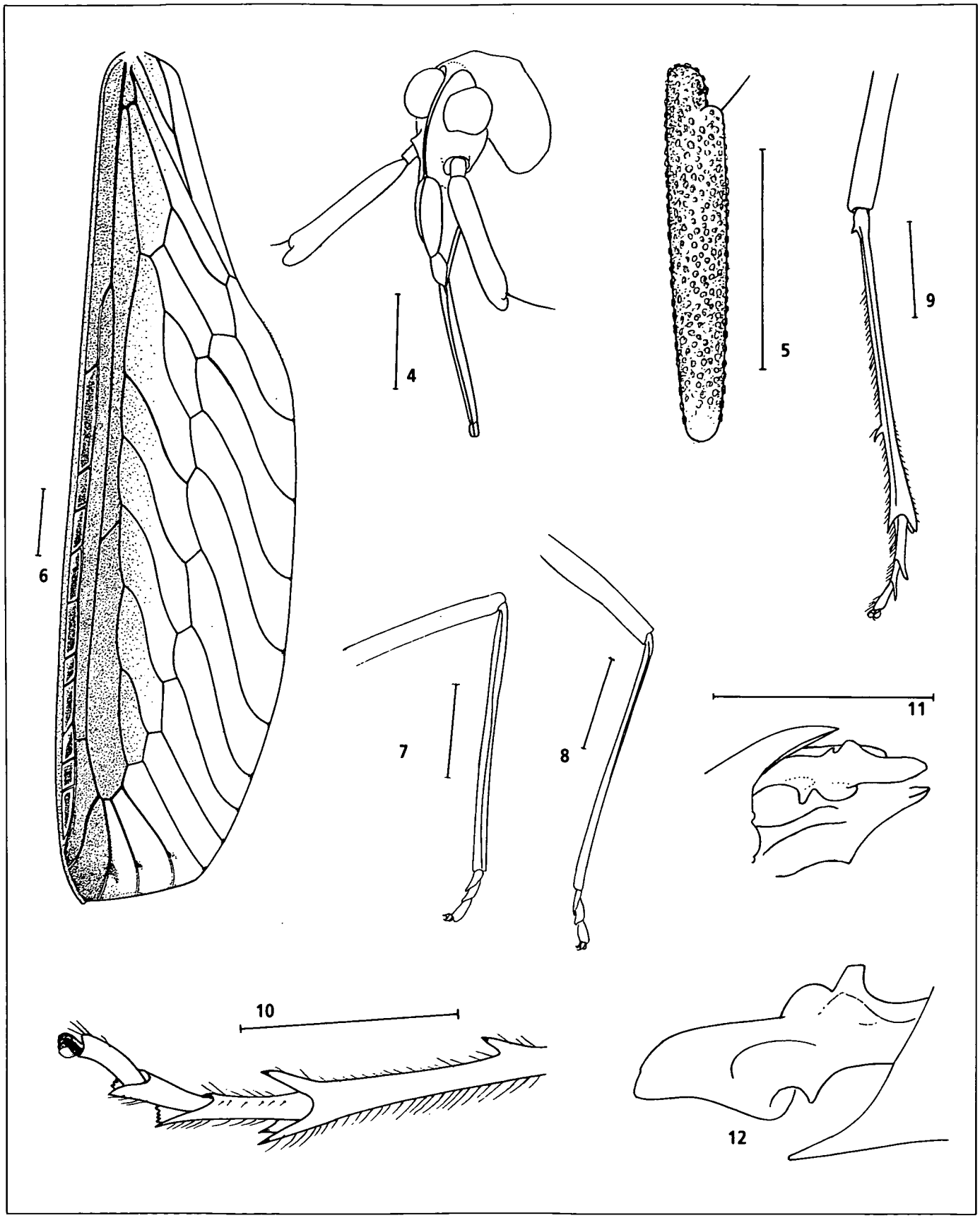
Zoraida (Zoraida) angolensis SYNAVE 1973

This specimen comes from the collection of the Department of Palaeontology, Natural History Museum, London. It is labeled [Derbidae / East African copal / det. A. Ross '00 / NHM Palaeont. Dept. In. 24743]. [*Zoraida (Zoraida) angolensis* SYNAVE 1973 / det. J. Szwedo 2001] The piece of copal is in form of cabochon, with the surface covered with cracks. The specimen is quite well preserved, in the piece of copal there are two partly preserved individuals (Figs. 4-12). One individual has the posterior portion of the body destroyed, and partly detached legs, left fore and mid legs missing. Frons in mid line about 1.35 times as long as postclypeus; anteclypeus about 0.46 times as long as postclypeus. Frontoclypeal suture convex. Postclypeus plus anteclypeus reddish, about 1.1 times as long as frons in mid line. Postclypeus with distinct median carina and two lateral carinae. Anteclypeus with distinct median carina. Rostrum 1.80 mm long, with apical segment 0.2 mm long and 0.13 mm wide. Antenna with second segment 1.7 mm long, about 7.1 times as long as wide; flagellum 0.62 mm long. Tegmina well developed, 12.2 mm long, 3.17 mm wide at widest point, elongate, with narrow base, clavus about 0.24 times of tegmen length. Venation typical of *Zoraida* KIRK., costal margin light, whitish, costal cells with fumose interior, anterior portion (subcostal and radial cells) fumose, basal portion, including claval field, slightly fumose. Veins darker, apical portions of RA branches and first M branch whitish. Costa slightly widened and flattened apically, Sc+R leaving basal cell with quite long common stem, Sc+RA with 10 transverse veinlets uniting it with C, RP with three terminals, common stem forking at the level of clavus apex. M with 7 terminals, two transverse veinlets r-m, the first near to 4th bifurcation of M, the second veinlet near the apex. CuA with 4 terminals, two transverse veinlets m-cu present (Fig. AA). Hind wings 1.37 mm long, 0.11 times as long as tegmen, venation not distinctly visible. Legs slender, fore femur 1.64 mm long, fore tibia 2.69 mm long, fore tarsus 0.59 mm long, first tarsomere shortest (0.17mm), second and third tarsomeres equal in length (0.29 mm). Mid femur 1.71 mm long, mid tibia 2.69 mm long, mid tarsus 0.6 mm long, structure of tarsomeres as in fore tarsus. Hind femur 1.51 mm long, hind tibia 3.41 mm long with distinct lateral spine slightly below half its length and the second, small spine near the femoral-tibial articulation. Tarsus 1.18 mm long, first tarsomere 0.68 mm long, second 0.44 mm, third (without claw) 0.35 mm, second and apical tarsomeres (measured with post tarsal structures) subequal in length. Femoral-tarsal spinal formula 5 : 5 : 5.

The other individual is a male, with the anterior portion of the body and legs missing, one leg detached near the corpus, only right tegmen preserved, left tegmen destroyed, left wing weakly preserved. Male genital block visible in ventrolateral aspect (Fig. 12). Style about 0.74 mm long, posteroventral margin of pygofer with semicircular median process and two smaller mediolateral processes. Regarding the tegmen venation, coloration and the details of male genital block, these individuals differ a bit from data presented in original description of *Zoraida (Zoraida) angolensis* SYN. (SYNAVE 1973). The original description was based on two male specimens and there are no data available about variability of this species. For this reason, we refrain from describing a new species, in hope that more data about both recent and fossil specimens are soon available.

Syninclusions: Diptera (3 individuals), Coleoptera (2 individuals, both partly destroyed).

In the collection of NHMW there are two other specimens of Derbidae, unfortunately poorly preserved. These specimens are labeled: [1984/31/30-C / Homoptera - Fulgoroidea / Ost Afr. Copal / Kollektion A. Handlirsch]



Figs. 4-12: *Zoraida angolensis* Syn. (4) head in laterofrontal view; (5) second antennal segment; (6) left tegmen; (7) fore leg; (8) mid leg; (9) hind leg; (10) hind tarsus; (11) male genital block of the second specimen in ventrolateral view; (12) left style; scale bar 1 mm.

and [Akquisition 1984/31/92 / Homoptera / Copal / Kollektion A. Handlirsch].

Family Issidae

One specimen from BMNH, labeled: [Gum Copal Inclusa E. Africa ~~91-52~~ In. 18256. Brit. Mus. (N. H.) G. D.]

A single specimen stored in NHMW is a nymph, poorly preserved, labeled [1984/31/32-C / Homoptera - Fulgoroidea / Ost Afr. Copal / Kollektion A. Handlirsch]; [Fulgoridenlarve / merkwündig ! / Ost Afr. Copal / Coll. Mayr]

Cicadomorpha

Cicadomorpha are a lineage comprising recent cicadas, froghoppers, leafhoppers and treehoppers and some extinct groups as well. Over 30,000 species have been described so far, these insects occur worldwide, but mainly in the tropics and subtropical zone. Their fossil record reaches to the uppermost Lower Permian, but the forms with more recent features appear in the Middle Triassic. These insects are relatively abundant in fossil record, both imprints and fossil resins.

Family Cicadidae

The species described by BUCKTON (1891) under the name '*Cicada forsythi*' represents Cicadellidae, not Cicadidae.

In the collection of NHMW a single specimen of cicada is stored. This specimen is weakly visible from the dorsal side, only face, lateral portion of the head, bases of tegmina and wings, and legs are visible, as well as part of the external portion of tymbals. The specimen is labeled [Akquisition 1984/31/33-C / Homoptera - Cicadidae / Ostafr. Copal / Kollektion A. HANDLIRSCH]; [Singzikade! ♂ / Stimmapparat ! / Ostafr. Copal / Coll. Mayr]

Family Cicadellidae

Cicada forsythi BUCKTON 1891: BUCKTO 1891: 183, plate G, fig. 26

The species was mentioned, given a formal name and figured in Buckton's „Monograph of British Cicadae or Tettigidae" (BUCKTON 1891), but the author himself remarked „... I omit its diagnosis until more perfect material are at hand to furnish it." He mentioned that the specimen was partly destroyed, with the dorsal side, frons and clypeus not visible. Judging from his drawing presented on plate G, fig. 26, it is not a representative of the Cicadidae, or even Cicadoidea, but rather Cicadellidae, as can be supposed from the structure of the fore leg and spinulation on the hind leg tibiae.

In the collection of NHMW a few other specimens are found. The first, with labels: [Akquisition 1984/31/34-C / Homoptera - Cicadellidae / Zanzibar Copal / Kollektion A. Handlirsch]; [Jassidae / Zanzibar Copal] is a poorly preserved male, with some recognizable details of the genital block, but with tegmina, wings, head and pronotum not visible. Another piece of copal, presumably East African copal, contains a specimen of Typhlocybinae and also a syninclusion of Fulgoroidea, probably Cixiidae. It is labeled [Akquisition 1984/31/35-C / Homoptera / Kollektion A. Handlirsch]; [Akquisition 1984/31/36-C / Homoptera / Kollektion A. Handlirsch]; [At · 26 / Cicada 2 H:].

Acknowledgements

We wish to thank Dr. Andrew J. Ross, Department of Paleontology, Natural History Museum, London, and Dr. Ortwin Schultz, Paläontologisches Department, Naturhistorisches Museum Wien, for the loan of the material, and Ms. Krystyna Warchał for the improvement of English.

This study was partly supported by the State Committee for Scientific Research (Komitet Badań Naukowych) grant No. 6P04C 073 18 awarded to senior Author.

Zusammenfassung

Ostafrikanisches Kopalharz ist reich an Insekten-Einschlüssen. Meist handelt es sich zwar nicht um Einzelfunde, aber dennoch ist die Zahl der aus Ostafrikanischem Kopal beschriebenen Arten relativ gering. Unter diesen sind Funde von Zikaden relativ selten. Das Alter dieser fossilen Harze ist zur Zeit nicht genau bekannt; meist werden sie dem Pleistozän zugerechnet (1-5 Millionen Jahre), möglicherweise stammen sie aber auch aus dem Pliozän.

References

AHD (2000): The American Heritage Dictionary of the English Language. Fourth edition. — Houghton Mifflin Company, Boston. xxxviii+2074 pp.

Bervoets R. (1910): Diagnoses de quelques nouvelles espéces de cicadines de l'ambre de la Baltique. — Annales Historico-Naturales Musei Hungarici, Budapest **8**: 125-128.

Buckton G.B. (1890): Monograph of the British Cicadae ot Tettigidae. Vol. I. — London. 133 pp., pls, A-H and pls. I-XXXVIII.

Buckton G.B. (1891): Monograph of the British Cicadae ot Tettigidae. Vol. II. — London. 211 pp., pls. XXXXIX-LXXIV.

Cockerell T.D.A. (1910): Some insects in Baltic Amber. — Entomologist **43**: 153-155.

Cockerell T.D.A. (1917): Insects in Burmese amber. — Annals of the Entomological Society of America, Columbus, Ohio **10**: 323-329.

Dietrich C.H. & F.E. Vega (1995): Leafhoppers (Homoptera: Cicadellidae) from Dominican amber. — Annals of the Entomological Society of America **88**(3): 236-270.

Durham J.W. (1956): Insect bearing amber in Indonesia and the Philippine Islands. — Pan-Pacific Entomologist **32**: 51-53.

Emeljanov A.F. (1990): A new genus and a new tribe of the family Achilidae (Homoptera, Cicadina) from the Baltic Amber. — Vestnik Zoologii **1**: 6-10.

Emeljanov A.F. (1994): Pervaya iskopayemaya nakhodka semeïstva Derbidae i pereopisanie paleogenovovo roda *Hooleya* Cockerell (Achilidae) (Insecta: Homoptera, Fulgoroidea). — Paleontologicheskiï Zhurnal **3**: 76-82.

Emeljanov A.F. & D.E. Shcherbakov (2000): Kinnaridae and Derbidae (Homoptera, Fulgoroidea) from the Dominican amber. — Neues Jahrbuch für Geologie und Paläontologie, Monatshefte **2000** (**7**): 438-448.

Fennah R.G. (1963): New fossil fulgorid Homoptera from the amber of Chiapas, Mexico. — University of California, Publications in Entomology **31**: 43-48.

Fennah R.G. (1987): A new genus and species of Cixiidae (Homoptera, Fulgoroidea) from Lower Creatceous amber. — Journal of Natural History, London **21**(5): 1237-1240.

Geinaert E. (1998): L'ambre. — Mineraux & Fosilles **266**: 2-40.

Germar E.F. & G.C. Berendt (1856): Die im Bernstein befindlichen Hemipteren und Orthopteren der Vorwelt. Königsberg. II. Bd. **II**, 1-40.

Gębicki C. & J. Szwedo (2000a): *Kulickamia jantaris* gen. et sp. n. from Baltic amber (Hemiptera: Fulgoroidea: Cixiidae). — Polskie Pismo Entomologiczne **69**(3): 167-173.

Gębicki C. & J. Szwedo (2000b): A fossil ugyopinae planthopper from Baltic amber (Hemiptera: Fulgoroidea: Delphacidae). — Polskie Pismo Entomologiczne **69**(4): 389-395.

Gębicki C. & P. Wegierek (1993): *Oligocixia electrina* gen. et sp. nov. (Homoptera, Auchenorrhyncha, Cixiidae) from Dominican amber. — Annalen Naturhistorisches Museum Wien **95** A: 121-125.

Grimaldi D. (1996): Amber - window to the past. — Harry M. Abrams Inc., Washington D.C. 216 pp.

Hillmer G., Voigt P.C. & W. Weitschat (1992): Bernstein im Regenwald von Borneo. — Fossilien, **9**(6): 336-340.

Hills E.S. (1957): Fossiliferous Tertiary resin from Allendale, Victoria. — Proceedings of the Royal Society of Victoria **69**: 15-20.

Hueber F.M. & J. Langeheim (1986): Dominican amber tree had African ancestors. — Geotimes **31**: 8-10.

Jacobi A. (1938): Eine neue Bernsteinzikade (Rhynchota, Homoptera). — Sitzungsberichte der Gesellschaft der Naturforschenden Freunde zu Berlin, Berlin **15**: 188-189.

Kleine R. (1924): Neue Arten der Gattung *Acicnemis* Lacordaire nebst faunistischen Mitteilungen. — Archiv für Naturwissenschaft **1924**: 140-162.

Langeheim J.H. (1973): Leguminous resin-producing trees in Africa and South America. In: Tropical Forest Ecosystems in Africa and South America: A comparative Review. — Smithsonian Institution Press, Washington D.C.: 89-104.

Linder H.P. (2001): Plant diversity and endemism in sub-Saharan tropical Africa. — Journal of Biogeography **28**(2): 169-182.

Oman J.P. & R.I. Sailer (1986): The role of cataloging in the advancement of systematics and biogeography. — Tymbal **7**: 16-21.

Poinar jr G.O. (1992): Life in amber. — Stanford University Press, Palo Alto, California. 350 pp.

Rice P.C. (1987): Amber, the Golden Gem of the Ages. 2nd edition. — The Kościuszko Foundation Inc., New York, Van Nostrand Reinhold Company, New York. 269 pp.

Ross A.J. (1999): Amber: the natural time capsule. — Harvard University Press. 74 pp.

Schlee D. (1984): Notizen über einige Bernsteine und Kopale aus aller Welt. — Stuttgarter Beiträge zur Naturkunde, Serie B Nr. **18**: 29-37.

Schlee D. (1990): Das Bernstein-Kabinett. Begleitheft zur Bernsteinausstellung im Museum am Löwentor, Stuttgart. — Stuttgarter Beiträge zur Naturkunde, Serie C Nr **28**: 100 pp.

Schlüter T. (1978): Zur Systematik und Paläoökologie harzkonservierter Arthropoda einer Taphozoozönose aus dem Cenomanium von NW-Frankreich. — Berliner geowissenschaftliche Abhandlungen, Berlin **1** (9): 150 pp.

Schlüter T. & F. von Gnielinski (1987): The East African Copal. Its Geologic, Stratigraphic, Paleontologic Significance and comparison with Fossil Resins of similar age. — National Museum of Tanzania Occasional Papers **8**: 32 pp.

Shcherbakov D.E. (1996): Origin and Evolution of the Auchenorrhyncha as shown by the Fossil Record. — In: Schaeffer C.W. (Ed.). Studies on Hemipteran Phylogeny. — Thomas Say Publications in Entomology. Entomological Society of America, 31-45.

SHCHERBAKOV D.E. (2000): Permian Faunas of Homoptera (Hemiptera) in Relation to Phytogeography and the Permo-Triassic Crisis. — Paleontological Journal **34**, Suppl. 2: 251-267.

STROIŃSKI A. & J. SZWEDO (2000): *Tonacatecutlius gibsoni* gen. and sp. nov. from Oligocene/Miocene Mexican amber (Hemiptera: Fulgoroidea: Nogodinidae). — Annales Zoologici **50**(3): 341-345.

SZWEDO J. (2000a): *Oliarus kulickae* sp. n. from Dominican amber (Hemiptera: Fulgoroidea: Cixiidae). — Polskie Pismo Entomologiczne **69**(2): 161-166.

SZWEDO J. (2000b): First fossil Tropiduchidae with a description of a new tribe Jantaritambini from Eocene Baltic amber (Hemiptera: Fulgoroidea). — Annales de la Société Entomologique de France (N.S.) **36**(3): 279-286.

SZWEDO J. & C. GĘBICKI (1998): *Ambericarda skalskii* gen. et sp. n. from baltic amber (Homoptera: Cicadellidae). — Polskie Pismo Entomologiczne **67**(4): 179-184.

SZWEDO J. & C. GĘBICKI (1999): Representatives of Petalocephalini (Homoptera, Cicadellidae: Ledrinae) in Baltic amber. — Estudios del Museo de Ciencias Naturales de Alava **14**, Número especial **2**: 201-206.

SZWEDO J. & R. KULICKA (1999): Inclusions of Auchenorrhyncha in Baltic amber (Insecta: Homoptera). — Estudios del Museo de Ciencias Naturales de Alava **14**, Numero especial **2**: 179-199.

SZWEDO J. & A. STROIŃSKI (1999): Redescription of *Tritophania patruelis* JACOBI, 1938 from Eocene Baltic amber (Hemiptera: Nogodinidae). — Annales Zoologici **49**(3): 203-207.

SZWEDO J. & A. STROIŃSKI (2001a): *Ptychogroehnia reducta* gen. n. from Eocene Baltic amber inclusion (Hemiptera: Fulgoroidea: Achilidae). — Annales Zoologici **51**(1): 95-101.

SZWEDO J. & A. STROIŃSKI (2001b): *Tainosia quisqueyae* gen. and sp. nov. from the Oligocene/Miocene Dominican amber (Hemiptera: Fulgoroidea: Nogodninidae). — Genus. International Journal of Invertebrate Taxonomy **12**(1): 29-34.

THOMAS B.R. (1968): Kauri Resins – Modern and Fossil. — Organic Geochemistry: 599-617.

USINGER R.L. (1939): *Protepiptera*, a new genus of Achilidae from Baltic Amber (Hemiptera, Fulgoroidea). — Psyche, London **46**: 65-67.

WEITSCHAT W. (1997): Bitterfelder Bernstein - ein eozäner Bernstein auf miozäner Lagerstätte. — Metalla, Sonderheft, Neue Erkenntnisse zum Bernstein - Internationales Symposium im Deutschen Bergbau-Museum **66**: 71-84.

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