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First insect inclusions from the amber of Jordan (Mid Cretaceous)

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With 2 plates

Contents

Abstract

In the Kurnub Series (Lower Cretaceous) of Central Jordan amber is concentrated in several levels of the Amber Member of the Subeihi Formation. It is found within parautochthonous lignitic beds as well as redeposited in marine sands. With the help of special preparation techniques the first insect inclusions were discovered within this brittle amber. Until now, only tiny but well-preserved dipterans (fam. Chironomidae and fam. Sciaridae) have been found. Some of the amber pieces show boreholes produced by marine pholadid bivalves. A revised lithostratigraphical scheme for the Kurnub Sandstone in central Jordan is presented.

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Zusammenfassung

In der Schichtenfolge der Kurnub-Serie (Unterkreide) Zentral-Jordaniens ist in mehreren Horizonten des Amber-Member der Subeihi-Formation Bernstein auf parautochthoner Lagerstätte bzw. Seife angereichert. Mit Hilfe differenzierter Untersuchungs- und Präparationsmethoden konnten erstmals Einschlüsse von Insekten aus diesem sehr spröden Bernstein nachgewiesen werden. Bisher sind ausschließlich sehr kleine, jedoch gut erhaltene Dipteren (Fam. Chironomidae und Fam. Sciaridae) gefunden worden. Einige größere Harzknollen zeigen Anbohrungen mariner Bivalven (Pholadidae). Eine lithostratigraphische Neugliederung des Kurnub Sandsteins wird vorgestellt.

I. Introduction

Lower Cretaceous amber from Jordan was first reported by BANDEL & HADDADIN (1979) and later intensively described by BANDEL & VAVRA (1981). The deposits are located in the area of Wadi Zerka, north of Amman. The amber is found in the Kurnub Series which is about 350 m thick, consisting of mainly fluvial silty and sandy sediments with several marine intervals. Here it appears concentrated in 'parautochthonous ' lignite beds as well as in placer deposits within silty to clay-rich horizons of the so called 'Amber Member' (BANDEL & SHINAQ, in prep.). In the amber-bearing strata fossils of *Agathis*-like plants were also discovered, and results of infrared spectroscopy indicate an araucarian origin of the Jordanian amber (BANDEL & VAVRA, 1981).

Further west of the Zerqa river a horizon within the Amber Member or basal Jerash Member has been dated by the ocurrence of the ammonite genus *Knemiceras* as of Albian age (WETZEL & MORTON, 1959). Investigations of the sporomorph fauna from the Amber Member support these data (AL-SAID & MUSTAFA, 1994).

The first insect inclusions of the Jordanian amber reported here are of particular interest. On one hand, because the amber is time-equivalent with the coming up of the flowering plants, on the other hand, because the fauna allows a comparison with insect inclusions described from the Lebanese amber (SCHLEE, 1970, 1972; SCHLEE & DIETRICH, 1970). They may lead to an answer of the question whether the Lower Cretaceous Middle East amber which reaches from the Libanon southwards via Syria and Jordan to Israel belongs to a single time equivalent amber forest or whether we have here several different stratigraphic levels containing amber.

Insect inclusions are quite rare in the Jordanian amber. Until now we have discovered only very few specimens, representing one insect order, the Diptera. However, we are confident to find representatives of other insect groups such as are known from the Lebanese amber, as soon as we have investigated more material.

During the Lower Cretaceous the Tethys separated the Euamerican region and the Asian Block on one side from the African-Arabian Plate and the South American Plate on the other side. Thus floral regions were separated from each other by the circumequatorial Tethyan Ocean. During that time Jordan was situated on the northwestern edge of the Arabo-Nubian shield which formed the relatively stable southern flank of the Tethys Ocean. Following a marine regression in the Late Jurassic the sea returned during the Early Cretaceous, to oscillate and start with in intensive marine invasion only during the early Late Cretaceous (Cenomanian), when most of Jordan was covered by sea well until the early Tertiary (until Mid Eocene time). The Neocomian-Maastrichtian sequence exposed in Jordan clearly exhibits an increase in marine influence with the Cenomanien transgression representing a major advance onto the African plate.

II. The Amber

The colours of the Jordanian amber range from translucent yellow to faintly translucent dark red, to brownish. Some pieces show intensive greenish fluorescence. Parts of the amber is turbid, being clouded by air bubbles or particles of small plant debris. Several pieces have a typical laminated structure in which it is possible to see how the individual layers have arisen as a result of a number of resin flows occurring in brief intervals. All pieces have a dark-red weathering crust.

Single amber pieces may reach the size of a man's fist, but usually they are much smaller consisting of irregularely rounded pieces measuring a few centimetres to small drops of a few millimeters. All material is extremely brittle, therefore larger specimen fall to pieces during weathering or during extraction from the surrounding rocks.

Small more or less spherical amber pellets can be found by washing the softer clay-rich, bioturbated sandstone that contains much lignitic material.

III. Material and methods

III.1. Preparation methods

The search for insect inclusions in the Jordanian amber is quite a difficult task compared with what we know from the Baltic amber. The size of the inclusions is usually not more than 1 - 2 mm, and the amber is only partly translucent, extremely brittle, and interspersed with numerous small reflecting fissures and streaks. In addition to that the amber pieces are covered by a dark red weathering crust which makes the search for insects more difficult. We use the special techniques of examination and preparation developed by SCHLEE & DIETRICH (1970) for searching, mounting and saving inclusions from the Lebanese amber.

For the search of inclusions every single piece of amber is placed in a small glass filled with Benzylbenzoat. This oil, which has a refraction index very close to that of amber, creeps deeply into the small fissures, displacing the air inside and thus making the amber piece translucent. If the piece of amber is too large and the oil does not reach the innermost parts it is necessary to fracture it further. After this procedure the amber can easily be examined by the help of a preparation microscope (20 to 40 times magnification). If an inclusion is discovered the piece of amber should be dried again and later casted in translucent natural resin for further investigations. We use a cold curing two component polyester resin (XOR). After hardening the polyester block with the embedded amber piece can be cut and polished. Different kinds of polishing planes which should be horizontal to the included fossil allow a detailed study of the insect.

III.2. Material

Insect inclusions are rare in the Jordanian amber. Among 300 amber pieces only five contained inclusions. In two of them 3 insects were found. All of the fossiliferous pieces belong to the same type of amber. It is yellow to brownish, and is characterized by a laminated structure, resulting from a number of thin resin flows at brief intervals. This is in accordance with other amber deposits where also mainly the laminated amber is fossiliferous. This phenomenon may be due to the fact that only this type of resin had flown down the bark of the tree becoming a fossil trap. Other kinds of resin were produced beneath the bark, within wood-fissures or within the roots thus never getting in contact with animals or plants.

The laminated fossiliferous amber from Jordan is also characterized by the presence of numerous small particles of plant debris which make the search for insects and the later study more difficult..

List of inclusions:

1: Yellowish-brown, laminated amber with one specimen (male) of the family Chironomidae (Diptera, Nematocera). Preservation quite good, but wings are cut off. Size of about 2 mm (pl. I, fig. 1); no.J.B.1.

2: Yellowish-brown, laminated amber with one specimen of the family Sciaridae (Diptera, Nematocera). Preservation very good. Size 1.2 mm (pl. 1, fig. 2); no.J.B.2.

3. Yellowish-brown, laminated amber with three specimens (2 males, 1 female) of the family Chironomidae (Diptera, Nematocera). Preservation good, one specimen only partly preserved. Size about 2 mm.

4. Yellowish-brown, laminated amber with three specimens of the family Chironomidae (Diptera, Nematocera). One excellent preserved other two only partly. Size about 2 mm.

5. Yellowish-brown laminated amber with a badly preserved midge, family uncertain.

IV. Amber bored by Pholadidae

Now and then larger amber pebbles are bored. The boreholes have a club-shaped outline quite like those found to be excavated by modern bivalves of the Pholadidae. Normally these bivalves bore into solid mudstone or lignite (*Pholas* etc), or wood (*Teredo Martesia etc.*). But as reported by MORTON (1971) *Martesia* and the related *Xylophaga* may also attack a variety of plastics. He reported that in Hong Kong waters *Martesia striata* has been found to be capable of tunnelling into the polyvinyl chloride tubes. This material can not be dissolved by weak acids or alkalis. The bivalve therefore bores strictly mechanically. This kind of boring without the help of substate softening bacteria as in the wood boring bivalve *Teredo* (BANDEL, 1988) or the aid of acids as in the case of *Martesia* in the Chinese Sea has been utilized by Cretaceous pholadids as well, which is documented by the bored amber. The bore holes have the same size and shape as those found in the modern plastic (compare with fig. 1, MORTON 1971).

V. Kurnub Formation

The Kurnub Formation (QUENNELL, 1951) of Jordan in the area of the valley of Zerqa River is about 300 m (BENDER, 1968) or 330 m thick (PARKER, 1971) and can be differentiated into four members (BANDEL & VÁVRA, 1981; SHINAQ & BANDEL in prep). The name Kurnub

Sandstone was first assigned in 1933, in an unpublished account of Damesin (according to PARKER, 1971) to sandstones exposed at Kurnub, near Beersheba in the Negev Desert. At Wadi Hathira in the northern Negev SHAW (1947) measured about 400 m of sandstones, in their central part he found the ammonite *Knemiceras compressum* HYATT. This horizon situated 120 to 150 m above the top of the Upper Jurassic (BENTOR & VROMAN, 1951) consists of sandy and limonitic limestone with a small fauna of ammonites, bivalves and some foraminifera, described by AVNIMELECH et al. (1954). It points to an early Albian age. PARKER (1971) created the subdivisions of the Kurnub Sandstone Series, a lower one called Aarda Formation and an upper one called Subeihi Formation. The lower about 30 m thick member of Aarda Formation was called King Talal Member by SHINAQ & BANDEL (in prep.). In the canyon of the Zerqa River the Kurnub is represented by sandstone with channel-deposits which in part consist of coal bearing silty layers (ABED, 1978). The King Talal Member is overlain by the about 100 m thick upper member of the Aarda Formation of PARKER (1971) that consists of varicolored and quite pure quartz sandstone of fluviatile derival called Ruman Member by SHINAQ & BANDEL (in prep.). ABED (1982) found a major direction of crossbeds towards the NE within this sequence with the sand derived from the SE and thus the Nubian Continent.

When marine influence increased again the third about 35 m thick member of the Kurnub Group and the basal one of the Subeihi Formation was laid down. Here sand filled channels and silty to clay-rich interlayers of the Amber Member were deposited (BANDEL & HADDADIN, 1979). It is overlain by about 130 m of the Jerash Member which consists of channel sands intercalated with thin silty beds and clay fills of channels both of which hold plant remains and trace fossils (BANDEL & HADDADIN, 1979; BANDEL & VÁVRA, 1981). According to PARKER (1971) the Subeihi Formation measures 132 m in thickness near its type locality 3 km west of Subeihi. A bed within the Amber Member or the basal Jerash Member has been dated further to the west of the Zerqa River near the road from Es Salt to Deir Alla by the occurrence of the ammonite *Knemiceras* as of Albian Age (WETZEL & MORTON, 1959) and this age has been confirmed by AL-SAID & MUSTAFA (1994) with the help of pollen and spores that they extracted from beds within the Amber Member.

The Kurnub Sandstone Group thus consisting of Aarda and Subeihi Formation and its four members King Talal, Ruman, Amber and Jerash overlie Mid-Jurassic limestones of Callovian age (BANDEL & ZEISS, 1987) of the Tahuna Member of Muadddi Formation (BANDEL,1981) with a slightly angular unconformity and they end in the glauconitic marls of the Cenomanian Rumeimin Formation (BANDEL & GEYS 1984). BLANKENHORN (1914) had first noted that the Nubian Sandstone in its upper portion is of early Cretaceous age and WETZEL & MORTON (1959) found the early Cretaceous sandstones of Jordan overlie the Jurassic bed with a clear erosional unconformity, which was supported by BANDEL (1981).

SHINAQ & BANDEL (in prep) compared outcrops with subsurface data from eight sections derived from drill sites in northern Jordan. They found that the Kurnub Sandstones form deposits on a rather flat plain near sea level. Before it had been eroded it had been faulted into a hilly landscape during latest Jurassic or/and earliest Cretaceous time (BANDEL, 1981). With begin of Kurnub deposition most of Jordan and certainly central and northern Jordan as far east as the Risha area (north-east Jordan) and the Azraq area (central east Jordan) began subsiding sufficiently so that fluviatile deposits were placed here permanently. The time of unrest before Kurnub deposition may be related to the larger tectonic unrest connected to the splitting up of the Gondwana continent. The begin of deposition also coincides with the world-wide rise of sea level at Aptian-Albian time. Northwestern Jordan had a position near the margin of the southern Tethys Ocean and the northern shores of the Nubian Continent. Sandstone was deposited by channels in a fluvio-deltaic system than thinned out and forked to the northwest thus forming a classic bird foot delta. Its pattern was reconstructed by COHEN (1986) based on drill data from Israel to the southeast of Tel Aviv. This delta that is present in the subsurface of northern Israel can be connected to the same river system that also deposited the Kurnub Sandstones of northern Jordan. The Jordan Rift resulted in a 110 km sinistral fault that has since moved Israel and the Sinai relative to Jordan and the bulk of Arabia displacing the delta fan. The Arabian Plate has since rotated somewhat in regard to the African Plate due to the opening of the Red Sea, but otherwise the delta of the Kurnub river system is known in its position on the margin of the Gondwana Continent.

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Plate 1

Fig.1: Diptera, fam. Chironomidae (male), from the amber of Jordan, Wadi Zerka. Coll. Geological-Palaeontological Institute and Museum, University of Hamburg; Typ.Kat.no. 3788.

Fig. 2: Diptera, fam. Sciaridae from the amber of Jordan, Wadi Zerka. Coll. Geological-Palaeontological Institute and Museum, University of Hamburg; Typ.Kat.no. 3789.

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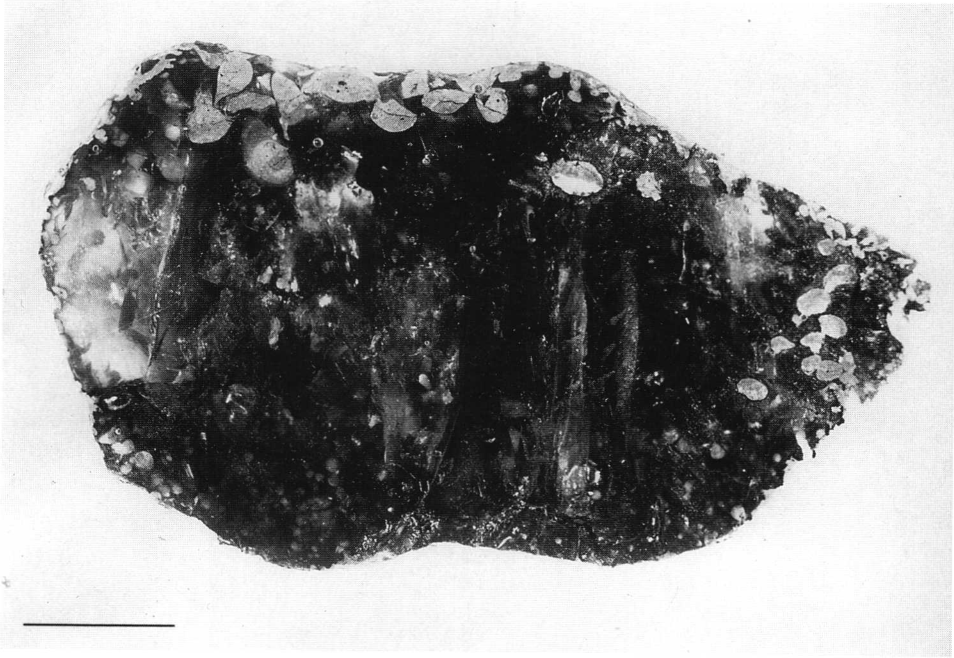
Plate 2

Fig. 1: Piece of amber with boreholes of pholadid bivalves; amber of Jordan, Wadi Zerka. Scale 1 cm.

Fig. 2: Enlarged details of the boreholes.

Specimens coated by Ammoniumclorite.



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