Detarioxylon aegyptiacum (Leguminosae), from Lower Miocene marine sediments in Southern Sinai.

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The petrified wood *Detarioxylon aegyptiacum* (Unger) Louvet & Boureau, Leguminosae, is new to Sinai. It is reported embedded in Rudeis Formation at Lower Miocene beds of Gebel Hadahid.

Key words**:** *Detarioxylon*, fossil wood, Leguminosae, Miocene, Sinai, Xylotomy.

Introduction

A large number of botanical and geological publications dealt with or referred to the occurrence of petrified tree trunks of spermatophytes (angiosperms and gymnosperms) at a large number of sites in the Eastern and Western Deserts of Egypt. An assemblage of a relatively large number of fossil tree trunks at a site, is usually referred to as a "petrified forest". There are many such petrified forests in the Western Desert of Egypt, however, the most famous one, the Qattamiya Petrified Forest, lies in the Eastern Desert and has been declared, some years ago, as one of the Egyptian natural protectorates. People, however, violate the rules and remove large pieces of these trunks from their original place in the desert (especially from Qattamiya) and take them away to decorate front gardens of their houses, shops, hotels or even streets. Removal from the original site in the desert is quite easy because the trunks are usually found lying horizontally on sand surface or only half-buried in sand.

Petrified forests or petrified trees have been reported from many places in the world especially Egypt. The main places from which petrified tree trunks have been reported in Egypt include: Qattamiya, Gebel Ahmer, Mokattam, Wadi Faregh, Wadi Natrun, Moghra, Gebel Ruzza, Qart El-Raml, Gebel El-Khashab, Qatrani, Dakhla and Kharga Oasis (Youssef, 1993; Dupéron-Laudoueneix & Dupéron, 1995; Kamal El-Din 1996, 1999).

The age of these petrified trees is usually referred to as Oligocene-Miocene (Dupéron-Laudoueneix & Dupéron, 1995; Kamal El-Din, 1996, 1999), however, there are records from the Quaternary (Kräusal,1939), Cretaceous (Youssef *et. al.*, 2000),

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Jurassic-Cretaceous (Youssef, 2001). The recorded trees belong to angiosperms (monocots and dicots) and gymnosperms. All records of angiosperms are, however, younger than Jurassic.

Up to the present there is no reference (geological or botanical) on the occurrence of such petrified tree trunks of spermatophytes in the Sinai Peninsula, neither in the Isthmic Desert in Northern Sinai nor in the mountainous South (Sinai Massif), except for the record of three specimens of *Palmoxylon* (*P. aschersoni, P. libycum* and *P.* sp) from the desert area between Gebel Hadahid and Gebel El-Bahr (Kräusal & Stromer, 1924). There are, however, some references on the occurrence of other remains of gymnosperms (quite few) and of pteridophytes (mainly ferns and lepidodendrales) in Pre-Tertiary strata in the Sinai Massif (Horowitz, 1973; Barakat *et. al.*, 1984; El-Saadawi & Kedves , 1984; Darwish & El-Kelani, 2001).

During his recent geological study of Tertiary deposits at Gebel Hadahid in Southern Sinai, the second author of the present paper, came across a fossilized tree trunk embedded in one of the beds of the Rudeis Formation of this mountain which is lower Miocene in age. The whole length of the trunk could not be determined because it is buried in a hard compact claystone bed and only a short length of the trunk could be uncovered with much effort (Fig. 1). The trunk measured about 20 x 47 cm in its cross diameter.

Fig. 1: One of the lower beds of Gebel Hadahid with a short length of the fossil trunk being uncovered.

A detailed botanical study of this trunk together with a brief study of the geology of the fossil-bearing bed and its underlying and overlying strata in the same formation of Gebel Hadahid make the aim of this paper.

Study Area

The study area lies in the eastern part of Gebel Hadahid to the south of Wadi Feiran and to the west of Gebel Abu Treifiya , it lies between Lat. 28º 40` to 28º 45` N and Long. 33º 20` to 33º 25` E (Fig.2).

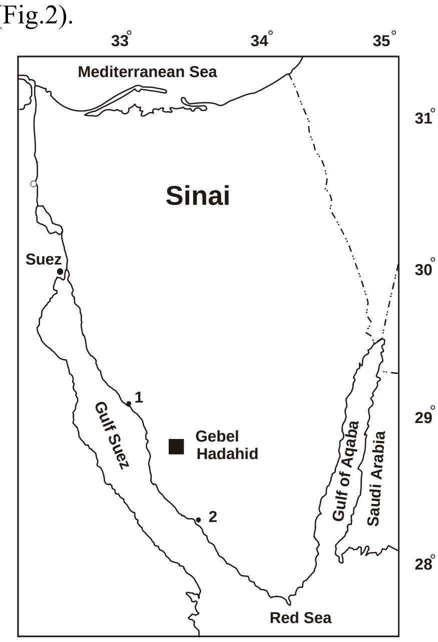

Fig. 2: Map of Sinai, showing location of the study area (Gebel Hadahid) and other main features (1: Abu Zenima , 2: El-Tor)

Stratigraphic setting and age of the plant-bearing horizon

The Miocene sequence has been subdivided into Lower Miocene referred to as Gharandal Group and Middle Miocene represented by Ras Malaab Group (National Stratigraphic Sub-Committee, 1974).

The Gharandal Group consists of the three following formations in ascending order: Nukhul Formation, Rudeis Formation and Kareem Formation. The first two formations cover the Early Miocene time span. In the study area, the Rudeis Formation (our main concern here) conformably overlies Nukhul Formation. The section of the Rudeis Formation exposed at Gebel Hadahid and studied in the present work is about 255 m.

The stratigraphic succession that composes the Rudeis Formation of Gebel Hadahid (Fig. 3) starts with fine-grained sediments which dominate the lower part. This is made up of green gypsiferous marl, silty marl and grayish yellow, massive, compact claystone interbedded with laminated siltstone with plant imprints and argillaceous limestone. These sediments are highly fossiliferous with planktonic and benthonic foraminifera suggesting that a deep open marine environment was prevailed during deposition of the lower part of the Rudeis section. The big trunk of the plant fossil has been recognized in the compact claystone in the lower part of the studied Rudeis section. The upper part of the Rudeis Formation of Gebel Hadahid is made up of a thick sequence of sandstone and less carbonate rocks. The sandstones are brownish yellow, fine to coarser, thick bedded, hard, calcareous, slightly glauconitic, cross-bedded and bioturbated. The sandstone becomes ferruginous, pebbly and coarser in size in the upper part of the section. The limestones are greenish grey to yellow, marly and sandy, glauconitic and colonized with oysters, echinoids, shell fragments and foraminiferal tests which lived in a shallow marine sea. The recognized facies and depositional environments of the Early Miocene Rudeis Formation exposed at Gebel Hadahid are summarized in Fig. 3.

Materials and Methods

A relatively large piece of the trunk about one foot long was brought from the site in Gebel Hadahid to the laboratory. Several small pieces were chopped off from the large wood log. Thin-ground sections (T.s, Rls, Tls) were prepared from a few selected small pieces according to the method described by Lacey (1963).

Microscopic investigation included detailed anatomical feature of the various elements of xylem. Microphotographs illustrating these features of the xylem were also prepared.

Silicification of the tree trunk

Silicification of plant remains is the most common among several preservation mechanisms for fossil wood, which include petrifaction by carbonates, sulphides, sulphates and phosphates. Silicification of wood (Drum,1968; Leo & Barghoorn, 1976; Sigleo, 1978) is not a replacement but a permeation or void-filling process. Fossilized wood composed primarily of quartz occurs in geological formations ranging in age from Palaeozoic to Tertiary (Stein, 1982). This is most probably due to the resistance of this mineral to physical and chemical weathering.

The fossil trunk was examined by X-ray diffraction in order to investigate its mineralogical composition. A small wood piece was powdered by hand in an agate mortar and mounted for X-ray examination using a SCINTAG/USA device. X-ray scan was run between 2° to 70° 2θ, at a scanning speed of 1° 2θ/min using Ni-filtered Cu radiation. The X-ray mineralogy of the studied petrified wood specimen consists almost entirely of quartz. This is also revealed from the petrographic examination of the thin sections of the recognized wood. Quartz grains are monocrystalline ranging in size from silt to fine sand. They are filling the wood vessels and preserve the wood texture. The existence of the trunk within the lower part of the Rudeis Formation which is rich in argillaceous sediments may have facilitated its silicification.

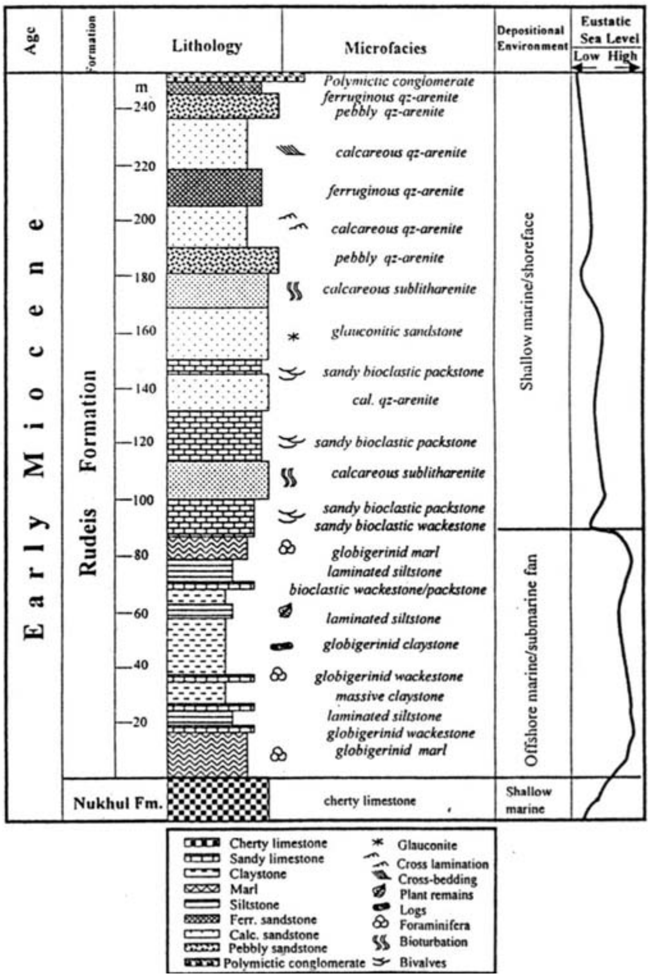

Fig. 3: Depositional facies and environments of the Early Miocene Rudeis Formation exposed at Gebel Hadahid.

Identification of the wood

It was clear from the surface features of the large wood log that it belonged to a dicot tree because xylem vessels, rays and concentric rings were quite visible to the un-aided eye. The vessels were easily seen because they were filled with a white powder-like material (proved later to be fine-grained quartz) while the rays appeared as thick parallel strands (Fig. 4).

Microscopic examination of transverse, tangential and radial longitudinal thin-sections of the wood proved that it belonged to *Detarioxylon aegyptiacum* (Unger) Louvet and Boureau. This species belongs to family Leguminosae and was widespread in the Tertiary rocks of Egypt. This is not only the first record of *D. aegyptiacum* from

Sinai but also the first from *in situ* beds, (all earlier records from Egypt were on the surface as already mentioned).

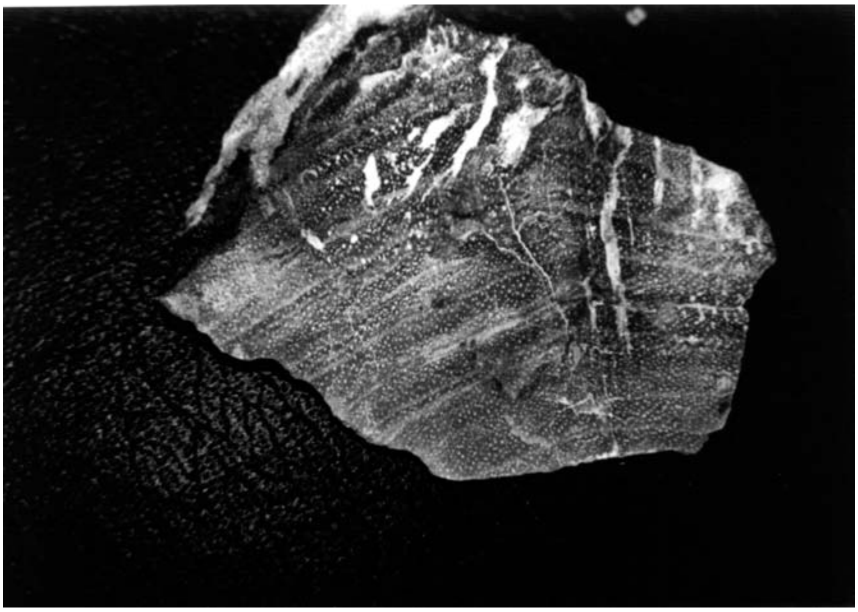

Fig. 4: A small piece of the trunk showing clearly xylem vessels (numerous white spots), parallel rays and concentric rings, x 1.8 .

Description

The following description of *D. aegyptiacum* is in accordance with the formate of the IAWA list of features suitable for hardwood identification (IAWA Committee, 1989).

Family : **Leguminosae**

Genus : ***Detarioxylon* Louvet & Boureau, 1970**

Species: ***D. aegyptiacum* (Unger) Louvet & Boureau, 1971**

Nicolia aegyptiacum Unger, 1858
Sterculioxylon aegyptiacum Kräusel, 1939
Detarioxylon libycum Louvet & Boureau, 1970

Growth rings distinct by marginal parenchyma and vessels (Fig. 5).Wood diffuse porous. Vessels predominantly solitary (Fig. 6), radial multiples 2-3 rare, round in shape. Late wood vessels mostly in tangential band. Tangential diameter 115-180 µm (mean 150 µm), radial diameter 145-200 µm (mean 165 µm).Vessels per sq. mm 5-7. Perforation plate simple. Intervessel pits polygonal, opposite, not crowded (Fig. 7). Vessel element length 330-500 µm (mean 430 µm). Gums and other deposits rarely present in vessels.

Axial parenchyma lozeng-aliform and confluent paratracheal (Fig. 8) and bands apotracheal. Parenchyma cells fusiform .

Rays homocellular, all procumbent cells (Fig. 9). Uniseriate rays extremely rare, multiseriate rays 3-7 (Figs. 8, 10). Ray heights 550-1050 µm, mean 770 µm. Nonstoried rays (Fig. 10).

Fibers with distinctly bordered pits without helical thickening, nonseptate (Fig. 10) and with thin to thick walled.

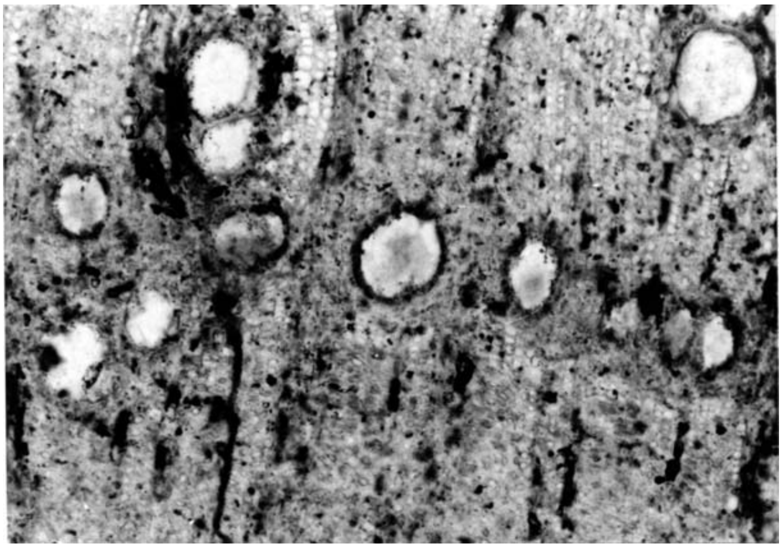

Fig. 5: Cross-section showing part of two distinct growth rings, x 107.

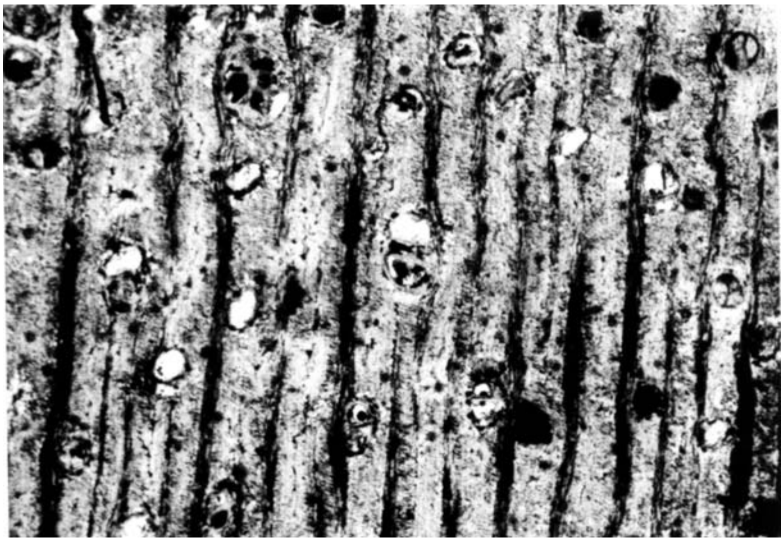

Fig. 6: Cross-section showing diffuse porous wood with solitary vessels, x 25.

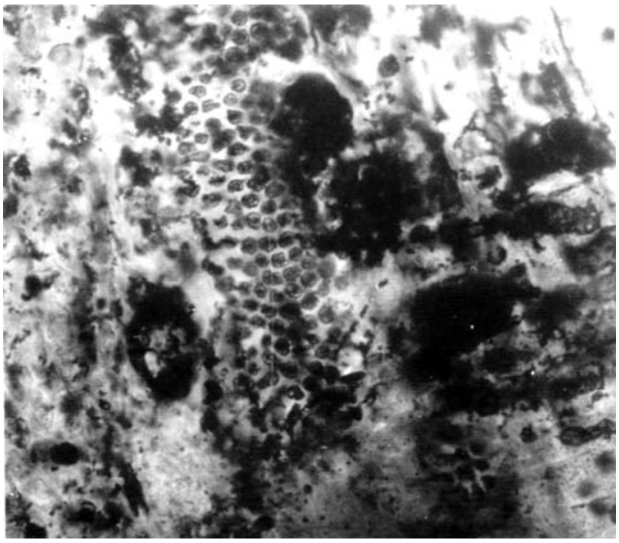

Fig. 7: Intervessel pits polygonal, opposite, not crowded, x 400.

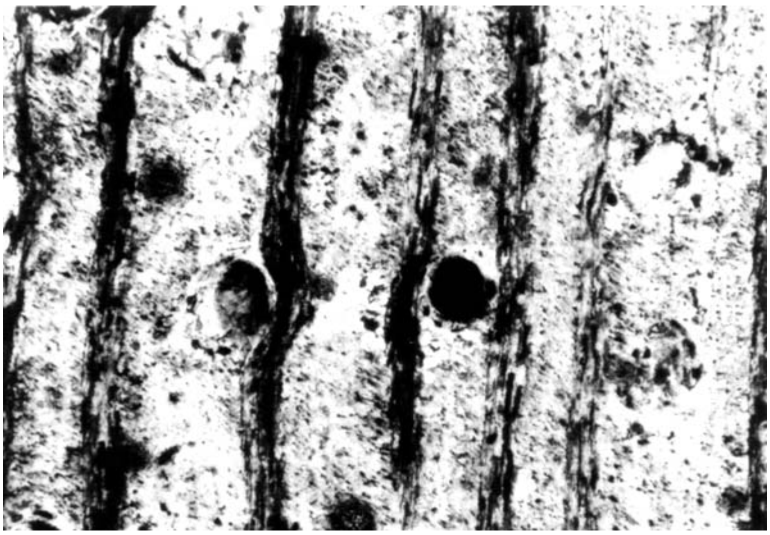

Fig. 8: Cross-section showing lozenge-aliform and confluent paratracheal parenchyma and multiseriate rays, x 166.

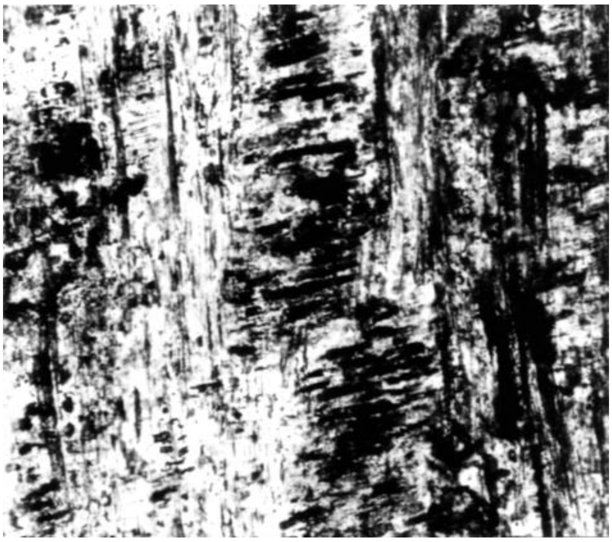

Fig. 9: Radial-section magnified to show procumbent cells, x 350.

Fig. 10: Tangential-section showing multiseriate and nonstoried rays with nonseptate fibers, x 200.

Comparison and Discussion

There are some slight differences in the description as given by Kräusel (1939), Youssef (1993) and as given in this paper, as follows:

Features	Kräusel (1939)	Youssef (1993)	This work
-Wood	diffuse porous	diffuse to semi ring porous	diffuse porous
-Tangential diameter in µm	100 - 240	90 -170	115 -180
- Radial diameter in µm	100 - 430	120 - 200	145 - 200
- Vessel element length in µm	150 -500	300 -500	330 - 500
- Vessels per sq. mm	2 - 8	_	5 - 7

So far eight genera represented by 11 species including *D. aegyptiacum*; all of family Leguminosae have been reported from Egypt (cf. Kräusel, 1939; Müller-Stoll & Mädel, 1967; Youssef, 1993; Dupéron-Laudoueneix & Dupéron , 1995; Kamal El- Din, 1996).

All these fossil wood taxa of Leguminosae are of Oligocene and / or Miocene age except *D. aegyptiacum*, which has a longer vertical range extending from Eocene through Oligocene, Miocene and Pliocene? to the Quaternary? (cf. Kräusel, 1939; Youssef, 1993; Dupéron-Laudoueneix & Dupéron, 1995).

In Africa *D. aegyptiacum* is known from Tertiary deposits in Algeria, Libya, Rio de Oro, Somalia, Tunisia in addition to Egypt (cf. Louvet, 1973; Dupéron-Laudoueneix & Dupéron, 1995)

In Egypt *D. aegyptiacum* was reported from of the following places: Birket Qarun,Qattamiya, Mokattam, Gebel Ahmar, Bir El-Fahm, Gebel Amuna, Wadi Ankebieh, Wadi Dugla, Fayum, Bahariya ,Helwan, Tanta, Giza Pyramids area, Gebel El-Khashab (Western Desert), Wadi Faregh, Moghara, Kharga, Kurkur, Wadi Sanur (cf. Kräusel & Stromer, 1924; Kräusel, 1939; Youssef, 1993).

The main anatomical features of the present specimen of *D. aegyptiacum* are: Growth rings; distinct. Wood; diffuse porous. Vessels ; mostly solitary, 5 - 7 per sq. mm, with simple perforation plates and mean diameter of 150 µm and 165 µm in tangential and radial directions, respectively. These features indicate tropical lowland habitats accompanied , however, by seasonal climatic variations (Baas *et. al.*, 1983; Carliquist, 1984, 1988; Baas & Schweingruber, 1987; Wheeler & Baas, 1993).

The trunk was, nevertheless, found in the lower part of the Rudeis Formation which is made up of fine-grained sediments rich in planktonic foraminifera that were deposited in a relatively deep marine environment. The presence of the trunk among marine sediments indicates most probably, therefore, that *D. aegyptiacum* trees were growing on elevated lands at relatively high altitude in the proximity of the Lower Miocene sea and then drifted away and deposited by a fluvial regime or other wise in submarine fan environment in deeper parts of the basin. The habitat at the relatively high altitude must have been drier as indicated by the distinct growth rings (cf. also Baas *et. al.*, 1983). Future search in the same formation (Rudeis Formation) at Gebel Hadahid will probably yield more useful information.

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