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New taxa of winteraceous pollen from the Lower Cretaceous of Israel

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ABSTRACT

This paper describes a rich assemblage of winteraceous pollen tetrads from the independently dated Albian Upper Hatira Formation at Makhtesh Qatan, northern Negev, Israel. Previously similar winteraceous tetrads have been reported from the upper Aptian-middle Albian of the Zohar 1 well north of Makhtesh Qatan. These pollen grains were widely recognized as early stem group representatives of the primitive angiosperm family Winteraceae, and a centre of origin in Northern Gondwana was postulated for a family, which is today mainly austral in distribution. On the basis of the new material from Makhtesh Qatan the new genus and species *Qatanipollis valentini* is proposed. In addition to its type this genus contains at present the two species *Qatanipollis* sp. A (formerly *Walkeripollis* sp. A) and *Qatanipollis* sp. B, both recovered from core samples of the Zohar 1 well.

1. Introduction

Sporomorph assemblages from the Lower Cretaceous of Israel have provided important clues for the early evolution of angiosperm pollen in general and of winteraceous pollen in particular. Based on subsurface material from Israel, Brenner and Bickoff (1992) and Brenner (1996) postulated an evolutionary sequence of early angiosperm pollen leading from small, reticulate inaperturates (Valanginian–Hauterivian) via monosulcates (from the Hauterivian onward) to tricolpate pollen types starting in the Aptian.

Perhaps even more remarkable was the discovery of a few highly distinctive winteraceous pollen tetrads in the upper Aptian–Albian of the Zohar 1 well in the northern Negev by Walker et al. (1983). These tetrads are composed of monoporate pollen arranged in permanent tetrahedral units and have been interpreted as belonging to the primitive angiosperm family Winteraceae (Walker et al., 1983; Brenner, 1996). A feature of this family commonly regarded as primitive is vesselless wood (e.g. Walker et al., 1983; Dettmann and Jarzen, 1990; Doyle et al., 1990), but this may be a secondary characteristic related to adaptation to cool, wet environments later in the history of the Winteraceae (e.g. Doyle, 2000; Feild et al., 2002).

Doyle et al. (1990) placed the Early Cretaceous winteraceous tetrads from the northern Negev as *Walkeripollis* sp. A in a newly described genus with the type species *Walkeripollis gabonensis* from the upper Barremian-lower Aptian of Gabon.

The presence of winteraceous pollen in the Early Cretaceous of Israel, which at the time was a part of Northern Gondwana (e.g. Brenner, 1976; Batten, 1984), has attracted much attention of scientists interested in the phytogeography of Winteraceae because it is in partial contrast to the mainly austral distribution (South and Central America, Madagascar, Australia, New Zealand, New Caledonia, Philippines) of their modern representatives (e.g. Dettmann and Jarzen, 1990; Doyle et al., 1990; Doyle, 2000; Friis et al., 2011). In general phytogeographic reconstructions suggest a much wider distribution of winteraceous pollen-producing plants in the Cretaceous and Cenozoic than today and at the same time they imply migration from a possible centre of origin in Northern Gondwana in a roughly southward direction (Doyle, 2000; Friis et al., 2011). The migration from the tropical lowlands of Northern Gondwana to temperate Southern Gondwana may have proceeded fairly rapidly because *Walkeripollis* sp. is present already in the upper Albian-Cenomanian of Patagonia (Barreda and Archangelsky, 2006).

Despite their importance in a phytogeographic and evolutionary context (see above) our knowledge of the winteraceous tetrads from the Zohar 1 well is based on quantitatively limited material: a single specimen pictured under light and scanning electron microscopy and very few additional specimens listed only in the text (Walker et al., 1983; Brenner, 1996). Recently rare winteraceous tetrads (less than 0.5% of the total palynoflora) were reported as *Walkeripollis* sp. A from a Lower Cretaceous surface exposure at Makhtesh Qatan in the northern Negev (Krassilov and Schrank, 2011), not far from the location of the Zohar 1 well. This lead to an intensive search for and the discovery of new winteraceous pollen material and its documentation using combined light and scanning electron microscopy. The main purpose of the present paper is the formal description and naming of this new and rich winteraceous material from Makhtesh Qatan (Figs. 1 and 2)

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and its comparison with additional winteraceous tetrads recovered by the author from cores 4 and 5 of the Zohar 1 well.

2. Stratigraphic framework, material and methods

Most of the palynological samples used for the present study (14) are derived from Lower Cretaceous outcrops in Makhtesh Qatan (synonym: Makhtesh Hazera) in the northern Negev. Three additional samples are from the Lower Cretaceous cores 4 and 5 of the Zohar 1 well situated about 27 km north of Makhtesh Qatan (Fig. 1). The term makhtesh is based on the Hebrew word for mortar and denotes an elliptical depression with steep walls, which may also be designated as an erosion cirque or breached anticline (e.g. Brenner and Bickoff, 1992; Mazor, 1993; Krassilov and Schrank, 2011). Outcrops in the three depressions Makhtesh Qatan, Makhtesh Hatira (Gadol) and Makhtesh Ramon together with the subsurface section encountered in the Zohar 1 well (Fig. 1) represent important sources of information on the Lower Cretaceous stratigraphy in the central and northern Negev (e.g. Brenner and Bickoff, 1992; Lewy et al., 1994; Gvirtzman et al., 1996; Weissbrod, 2002; Segev et al., 2005; Krassilov and Schrank, 2011).

A detailed description of the Lower Cretaceous succession in the Makhtesh Qatan depression was given recently by Krassilov and Schrank (2011). This succession is dominated by fluvial sandstones of the Hatira Formation of a total thickness of about 360 m, which overlie Upper Jurassic carbonates and are overlain by upper Albian to lower Cenomanian carbonates of the Hazera (Hevyon) Formation (Segev et al., 2005; Krassilov and Schrank, 2011). The lower part of the Hazera Formation at Makhtesh Ramon has yielded the ammonite *Hypengonoceras* of late Albian age (Lewy, 1981), which was later found to be associated with a typically late Albian (-early Cenomanian) pollen assemblage including *Elaterocolpites castelainii* and *Elaterosporites klaszii* (Weissbrod et al, 1994), both characteristic members of the African-South American microfloral province (e.g. Herngreen and Duenas Jimenez, 1990; Herngreen et al., 1996). Further age control of the Lower Cretaceous succession comes from fossil fauna associated with marine intercalations in the continental siliciclastics. According to Weissbrod (2002) and Segev et al. (2005 and sources therein) three marine intercalations or 'tongues' can be found in the Makhtesh Hatira and the neighbouring Qatan depressions. These are from base to top:

(1) the Zuweira marine tongue with the bivalve *Protocardia judaica*, age early Aptian;
(2) the Deragot marine tongue, age of the lower part late Aptian, age of the upper part with the ammonite *Knemiceras* early Albian;
(3) the Uza marine tongue with fragments of ammonites (*Knemiceras dubertreti*), age middle to late Albian.

The ammonite occurrences mentioned above are restricted to Makhtesh Hatira. No marine macrofossils were reported from Makhtesh Qatan (Krassilov and Schrank, 2011), apart from a few bivalves, gastropods, crustaceans and trace fossils from the lower Aptian Zuweira marine tongue (Lewy et al., 1994).

On the basis of the marine intercalations cited above equivalents of the Hatira Formation (or Kurnub Group) can be subdivided into 4 formations (e.g. Brenner and Bickoff, 1992; Segev et al., 2005). In the present paper I follow Gvirtzman et al. (1996), Krassilov and Schrank

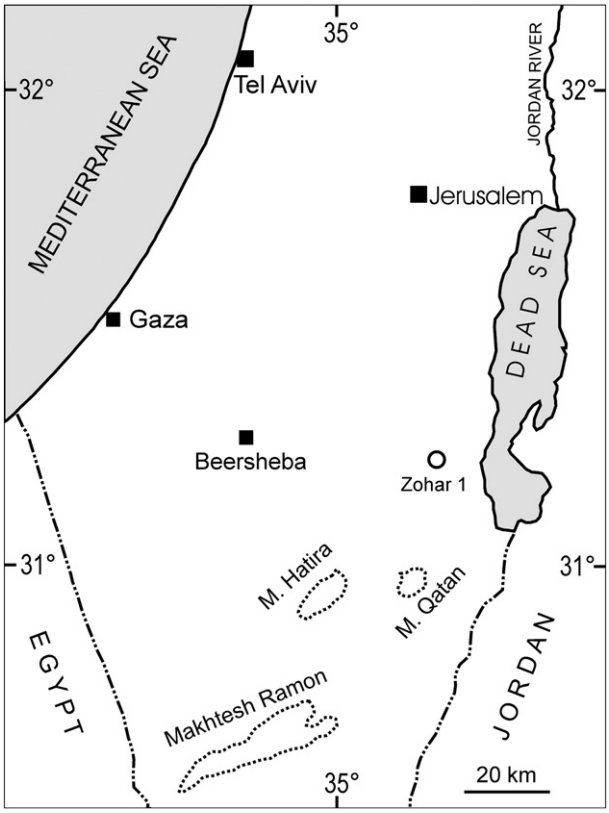

Fig. 1. Sketch map of the northern Negev and adjacent areas west and south-west of the Dead Sea showing Cretaceous localities including the studied Makhtesh Qatan depression and the Zohar 1 well. Modified and redrawn after Sandler (1996) with additional information from Grader and Reiss (1958).

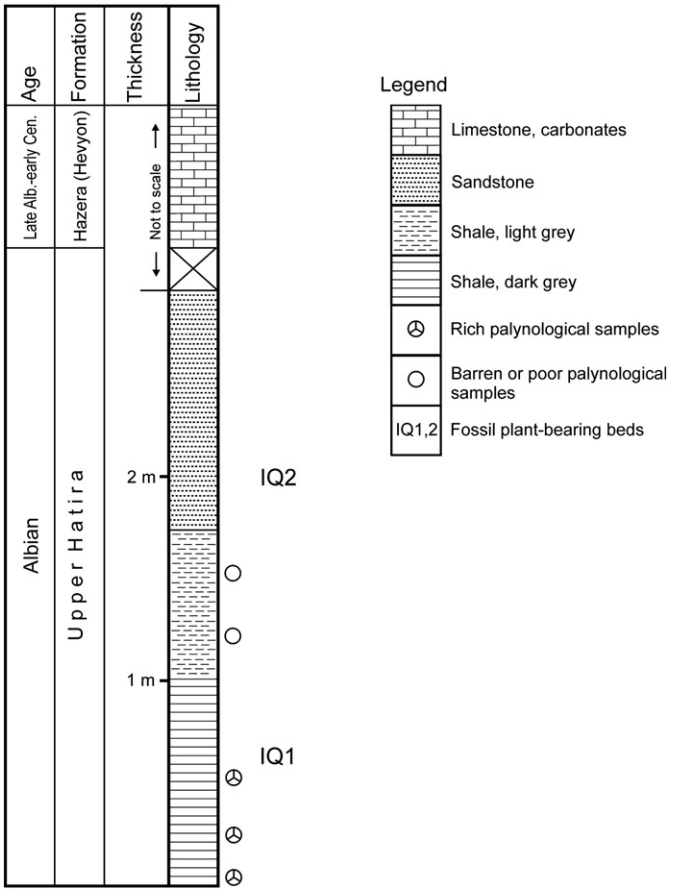

Fig. 2. Schematic stratigraphic section of the Upper Hatira Formation in the Makhtesh Qatan at fossil plant-bearing beds IQ1-2 (Krassilov and Schrank, 2011; 30°58.227′N; 35°10.898′E). The IQ1 bed is represented by the basal shale and IQ2 by the immediately overlying sandstone. Winteraceous pollen tetrads were recovered from the rich palynological samples in the lower part of the shale unit IQ1. The three spore sketches (circles with y mark) at the base of the section symbolize a total of 14 winteraceous pollen-bearing samples recovered from the present section and from a few parallel subsections within a horizontal distance along the outcrop of the IQ1 bed of about 80 m.