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Jurassic plants from Djebel Tih, Sinai

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With 36 figures

Contents

Abstract

A flora of Jurassic age from Djebel Tih (southwestern Sinai) is described and illustrated. Two representatives of the Equisetophyta, six of the Pterophyta, one of the Cycadophyta and eight of the Coniferophyta were encountered.

Zusammenfassung

Eine jurassische Flora des Djebel Tih im südwestlichen Sinae wird beschrieben und abgebildet. Hierunter befinden sich zwei Verteter der Schachtelhalme, sechs der Farne, eine Zykadee und acht Koniferenreste.

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I. Introduction

Jurassic floras from the Sinai and Southern Israel have been studied since 1959 (LORCH 1959, 1963, 1967a, b 1968; CHALONER & LORCH 1960; RAAB et al. 1986). Most of these floras come from the Negev desert (Southern Israel) where the two floras of Makhtesh Ramon are the best known (LORCH 1959, 1963, 1967b, 1968; CHALONER & LORCH 1960). These are situated in the Lower Marine Series (LORCH 1959, 1963, 1968; CHALONER & LORCH, 1960) of probably early Jurassic age, and the Upper Marine Series (Cycle Formation), some 300 m above the lower flora (LORCH 1963, 1967b) of probably Bajocian - Bathonian age. RAAB et al. 1986 described a conifer species from a borehole South of Jerusalem of a late Jurassic age.

So far, only one Jurassic flora has been described from the Sinai (LORCH 1967a); this flora originates from the Djebel Maghara massif (Northern Sinai) and contains eight species, mainly ferns. Its exact age is unknown but is probably Middle Jurassic.

From an adjacent area in Egypt (Ain Sukhana, 55 km south of Suez), ASH (1972) described a florule of probably early Jurassic age and from the same area CARPENTIER & FARAG (1948) described some fossil plants of presumed Rhaetian age. EL-SAADAWI& FARAG (1972) and EL-SAADAWI& KEDVES (1991) described several fern, bennettitalean and conifer remains from probably early Cretaceous beds in the Abu-Darag area (Egypt), while WEBBER (1961) described some ferns from a probably early Cretaceous core from the Western desert of Egypt.

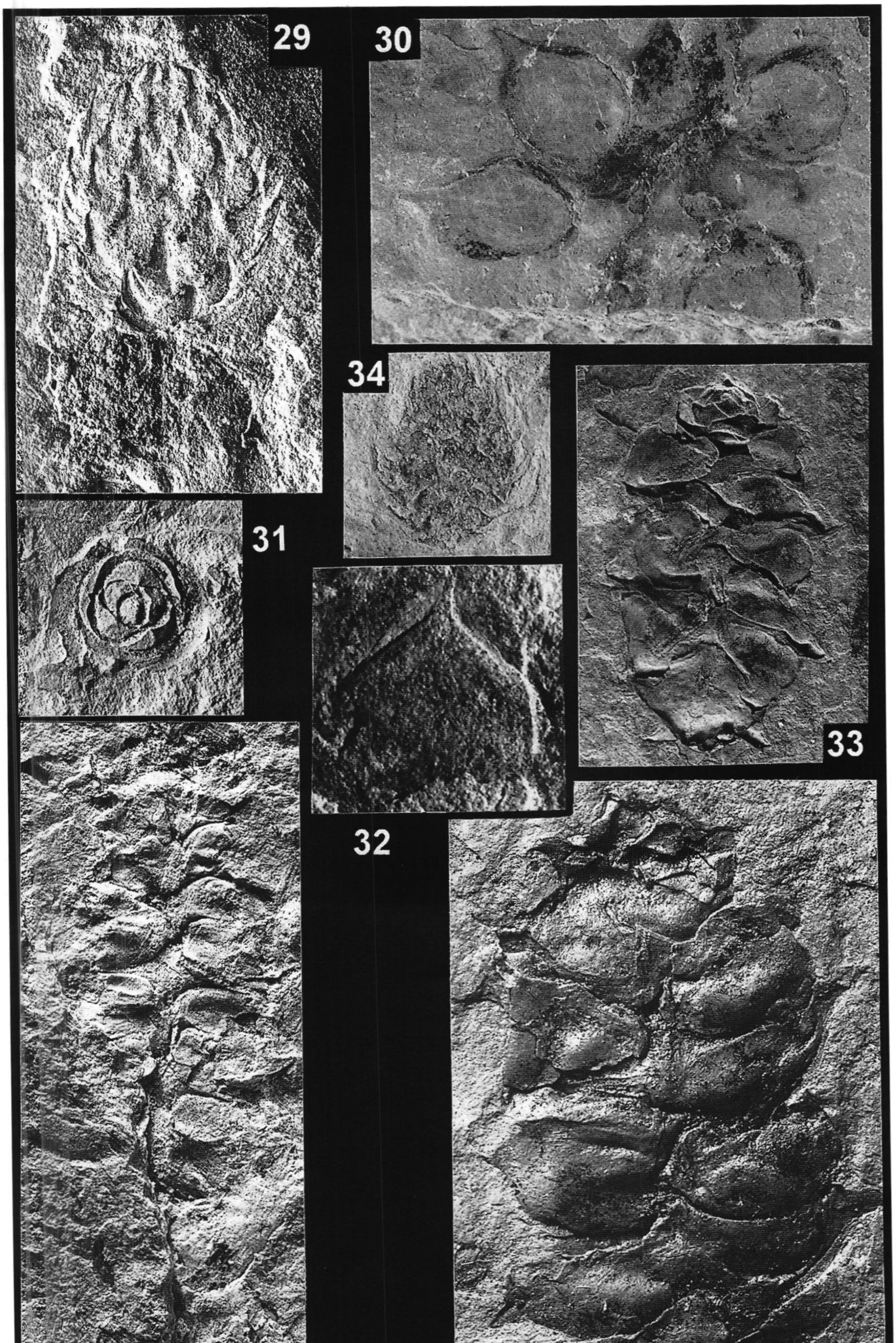
The flora described in this paper originates from fossiliferous layers at the Djebel Tih in the Sinai, which were previously thought to be Carboniferous in age. However, the flora that was recovered from these sediments is quite similar to the Jurassic floras from both the Sinai and Makhtesh Ramon, and is, therefore, of Jurassic age.

The flora is here described as an annotated species list, as most of the species collected at Jebel Tih are already well-known from other floras in the area. In this list the references where the taxa have been described in detail will be given. Only those species that are either new to the area or which represent new forms will be discussed in more detail.

II. Geology

According to REYNOLDS et al (1997) Gondwana rotated clockwise during Jurassic time in such a way that around 158 Ma the paleoequator passed through the Nile delta. The Arabian platform lay around latitude 5°N. The passive margin of the Neotethys Ocean lay to the northeast of the Arabian Platform and the shoreline during Jurassic time can be reconstructed from exposures in Jordan and Israel, as well as from exposures near the end of the Gulf of Suez in Egypt in northern Sinai.

From Jordan BANDEL (1981) described Jurassic rocks in outcrops from just NW of Es Salt exposed in northward direction in the slopes of wadis up to the Wadi Zarqa between the King Talal Reservoir and the town of Deir Alla. Further to the south Jurassic rocks have been eroded in the lower Cretaceous and further to the north they are covered by younger deposits. The rock column was split into 19 sedimentary cycles, each of which shows a terrestrial, near shore or fluviatile lower portion and an upper part that was deposited under fully or nearly fully marine conditions. The upper part of the sequence is still of mid Jurassic age (BENDER 1968, BANDEL & ZEISS 1987). At the very top of each cycle the begin of withdrawal of the sea usually is documented. Within the area of outcrop, extending from the North to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16. Of *Hirmeriella* sp. three more or less complete cones have been preserved, two with part and counter part (figs.30, 32, 33, 36). The best-preserved one shows a 3 cm long, 1.5 cm wide cone (no base preserved) consisting of spirally arranged bracts (ca. 8-9 mm wide, 5-6 mm high) with a distinct vertical median keel, just as has been described for the type-species *H. muensteri* (CLEMENT-WESTERHOF & van KONIJNENBURG-van CITTERT 1991). Apically, a few smaller scales occur, and possibly an ovuliferous scale could be observed.

The other cone of which both part and counterpart have been preserved is 2.5 cm long and 1.4 cm wide. The bracts are up to 8 mm wide and 5 mm high, and near the apex a typical 5-lobed ovuliferous scale can be seen. The base has not been preserved, but the specimen lies next to a *Watsoniocladus harrisianus* shoot. The same applies for the third cone, which is 3.3 cm long and 1.5 cm wide. The bracts are ca. 8 mm wide and 4 mm high, and apically again a 5-lobed ovuliferous scale could be observed.

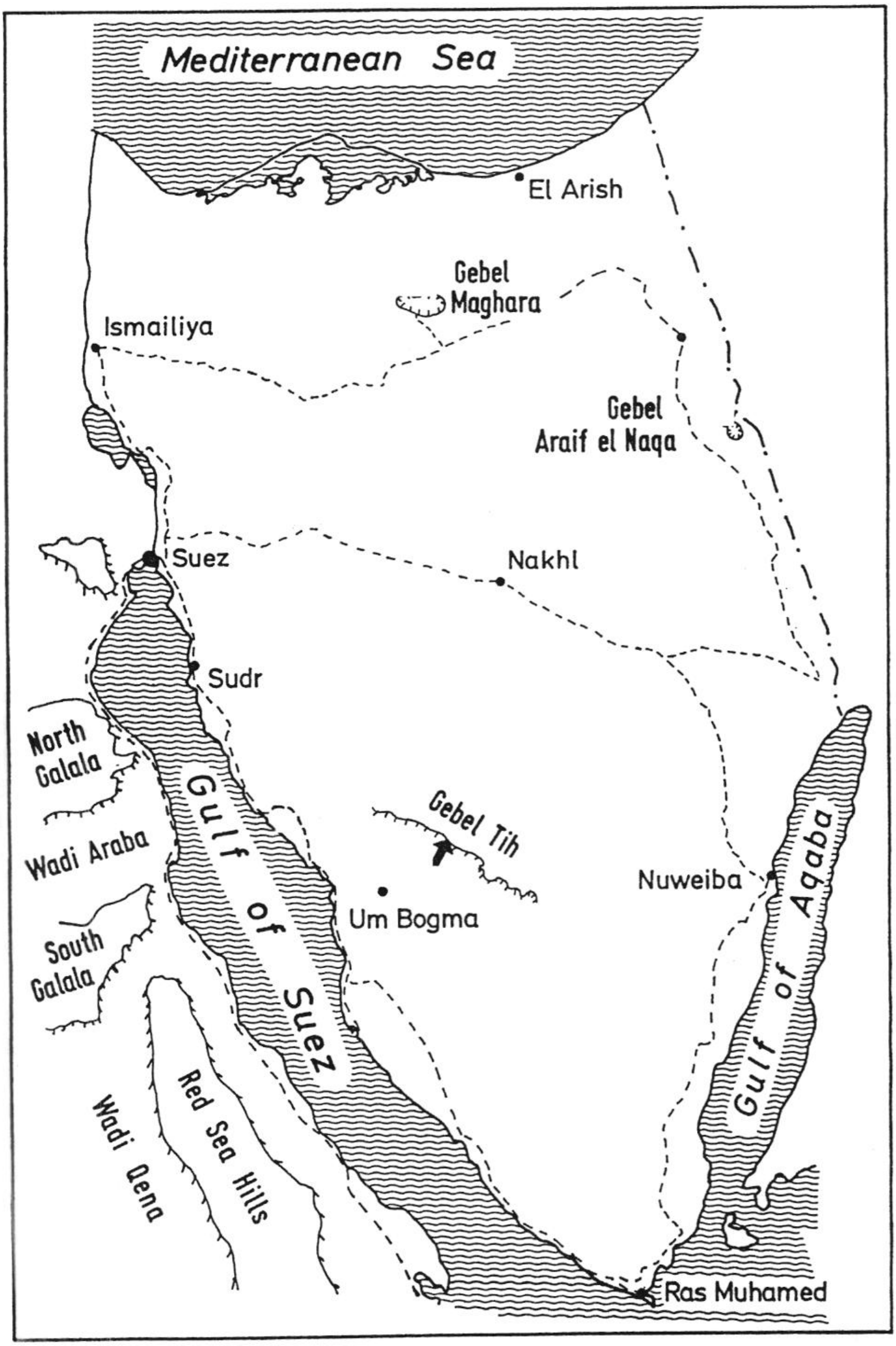
Next to the complete cones, several separate ovuliferous scales occur. They vary in size between a width of 6-9 mm and a height of 5-6 mm. On one, the impressions of two possible seeds were present, on another specimen a distinct seed was still present (6 mm high and 4 mm wide, with a clear, acuminate micropylar area). Another specimen showed a cluster of 4 seeds, all of the same shape and size as mentioned before, that seemed to be attached to an axis but this axis was indistinct, and there was no clear evidence of any remaining ovuliferous scales. Similar seeds have been described by LORCH (1967b) from Makhtesh Ramon, where they are quite common and also often occur in such clusters. It is our opinion that they might belong to *Hirmeriella*.

The cones resemble closely those that have been described for *H. muensteri* from the Lower Liassic of Germany with their keeled bracts, and five-lobed ovuliferous scales (see e.g. CLEMENT-WESTERHOF & van KONIJNENBURG-van CITTERT, 1991). The only differences are the slightly larger number of bract/ovuliferous scale complexes found per cone (usually around 10 in *H. muensteri,* but a higher number occurs, and around 15 in the present material) and the absence of a transversal keel that is often present on the bracts as well in *H. muensteri* (see figs.33, 36). The seeds found associated both in the here described assemblage and in Israel (LORCH 1967b) probably belong to *Hirmeriella* as well. This would be a real difference with *H. muensteri* material because there separate seeds are very rare (but of the same size and shape as the present ones); when preserved they are usually still attached to the ovuliferous seed (see CLEMENT-WESTERHOF & van KONIJNENBURG-van CITTERT 1991).

The association of the present cones with sterile material of *Watsoniocladus ramonensis* strongly suggests that both belong to the same plant. The male cone of *W. ramonensis* (*Classostrobus harrisianus* (LORCH) ALVIN et al. 1978) has already been described by LORCH 1968 and also occurs in the present material. The presence of female *Hirmeriella* cones associated with this material proves that it all indeed belongs to the fossil conifer family Cheirolepidiaceae.

17. *Masculostrobus* sp. Three male, probably coniferous cones occur in the present material that are more or less round, ca. 5-6 mm in diameter (fig.34). In the best preserved specimen, small spirally arranged (micro) sporophylls can be observed, but no more details are visible. Therefore, these specimens are simply attributed to the genus *Masculostrobus* (fig.34) without any specific assignment.

18. A single seed has been found that closely resembles a sunflower seed! The shape is more or less triangular; the seed is ca. 1 cm long and basally (where the chalaza is visible)



Location map of Sinai and part of the Eastern Desert (from KUSS & BANDEL, 1987).

the South for about 15 km, often the shore had been present and the divide between terrestrial and marine conditions can be crossed in time equivalent beds. Thus, when neighbouring sections can be compared with each other, the southern of both was commonly deposited under terrestrial or intertidal conditions, while the northern was laid down under nearly of fully marine conditions. The sea always came from the NW, while a river system or large delta area of a river discharged its sediment load coming from the Gondwana Continent in the SE.

In southern Israel the Jurassic is exposed (Slatkine & Heller 1961) in the Makhtesh Ramon in the Negev. Its pisolitic basis similar to that in Jordan and had formed under tropical weathering. Palynostratigraphic considerations led Conway (1990) to assign an Upper Pliensbachian age, and a coniferal flora from the " flint clay" was described by Chaloner & Lorch (1960) and Lorch (1968). In Makhtesh Ramon the Flint Clay sequence crops out almost continuously over a length of 26 km, and is also exposed in Makhtesh Arif, while in Jordan this layer is exposed only in a small area of Wadi Huni within the lower Wadi Zerqa (Bandel 1981). The marine Nimr Member above this base in Jordan can be compared with the Ardon Formation (Goldberg & Friedmann 1974) which measures between 0 and 240 m. It is similar in thickness as in Wadi Zarqa (Jordan) at Makhtesh Ramon (Israel), about 70 km SW of the southern end of the Dead Sea. Parnes (1981) found here the gastropod *Nerinella janeti* Cossmann, which suggests a Lower Liassic age. Zarqa Formation of Jordan represents Inmar Formation of the Negev or parts of it. This about 300 m thick sequence consisting of sandstones with a fauna including the brachiopod *Gibbirhynchia*, which suggests late Liassic age (Parnes 1980, 1981). A flora from the top of the formation consists of Filicales and Benettitales (Lorch 1967). The flora is of early Dogger age. The Lias-Dogger transition is within this series, which is also quite possibly the case within the Zarqa formation in Jordan. Dhahab Formation of Jordan can be compared with the Daya Formation (Goldberg & Friedmann 1974) or Mahmal Formation described by Parnes (1981). This sequence is transgressive over the deltaic sandstones of the Inmar Formation. At Makhtesh Ramon it is eroded and overlain by early Cretaceous conglomerates of the Kurnub Formation. In the late Jurassic the sea probably still covered the area of modern Jordan, but beds have become eroded, while they have been preserved in Israel. Hirsch & Picard (1988) described foraminifera from early Kimmeridgian from the Negev and the subsurface of northern Israel.

At the little village of Um Bogma at the western side of Sinai and at the base of Djebel Tih the oldest sediments resting on the truncated basement are equivalents to the Um Bogma Formation of Bandel et al (1987). They described in detail the exposures of Um Bogma Formation on the western side of the Gulf of Suez. It was noted by Jochen Kuss and one of the authors (Klaus Bandel) that this silty sandstone and silt beds intercalated into sandstones and arcosic series is extensively exposed in the area of the village of Um Bogma on Sinai. Here traces document that trilobites lived here producing resting tracks, crawling trails and feeding traces. This rock sequence is of older Paleozoic, probably Cambrian age like similar deposits in Jordan (Bender 1968, Bandel 1987).

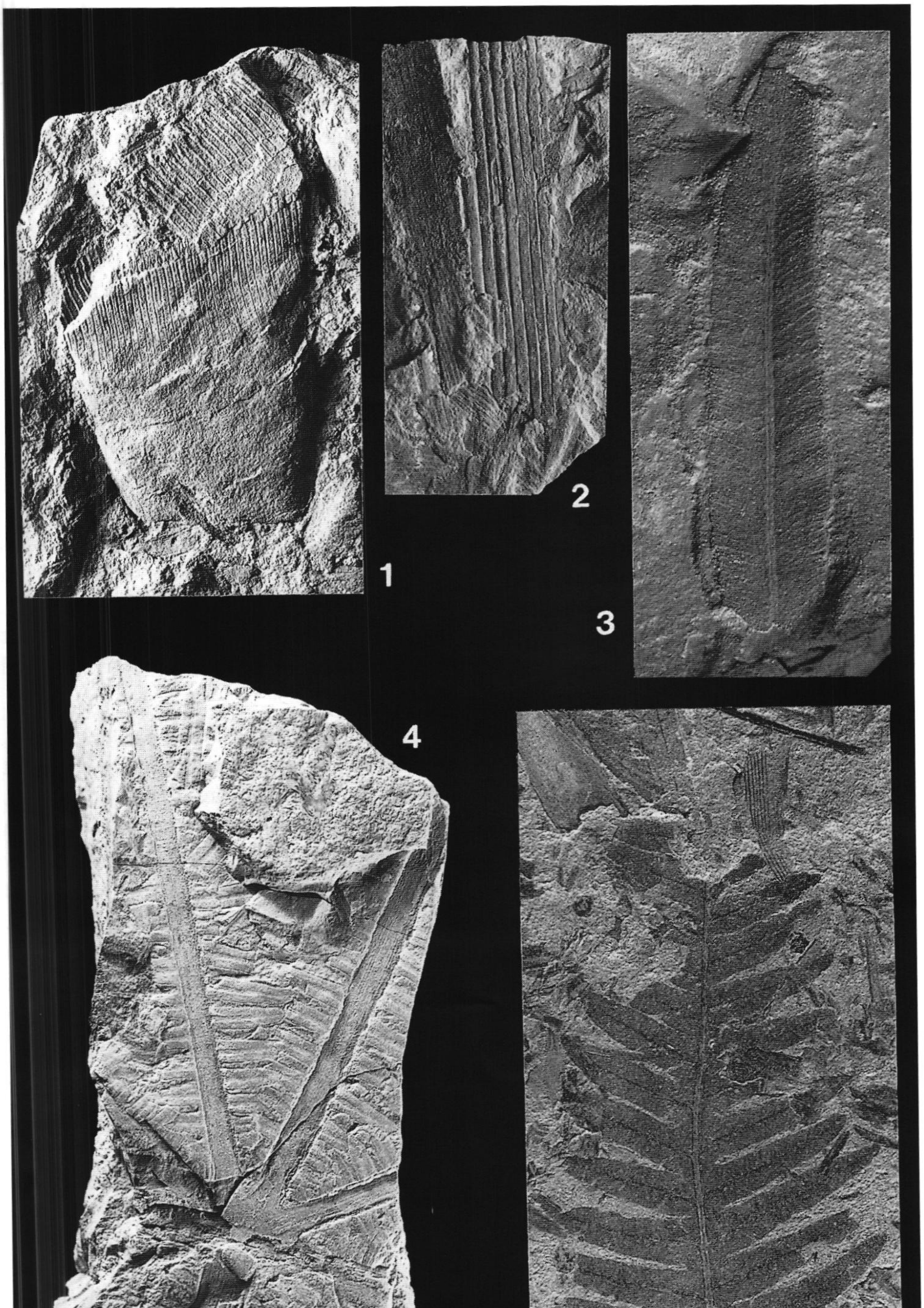
Fig. 1: Stem of *Equisetum columnare* Brongniart, about 4 cm in width.

Fig. 2: Stem remain of *Neocalamites* sp., about 1 cm wide.

Fig. 3: Pinna of *Phlebopteris* sp. cf. *P. muensteri*, about 5 mm wide.

Fig. 4: Slab with *Phlebopteris* sp. cf. *P. muensteri*, about 10 cm in maximum height.

Fig. 5: Leaf of *Phlebopteris* sp. cf. *P. muensteri*, about 2 cm wide.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The Cambrian beds are truncated and overlain by early Carboniferous rocks with corals and brachiopods. The truncation is inconspicuous, but clearly indicated by the fossils found within the limestones, which follow just above the basal coarse conglomeratic sandstone. Equivalent beds are not found in Egypt on the other side of the Gulf of Suez (BANDEL & KUSS 1987) and in Jordan. Subsidence and sedimentation had returned to the area of Sinai-Israel-Jordan sometimes during the early Carboniferous (Late Tournaisian) after the area had become land during the Mid Paleozoic. The eroded plane was covered with several hundred meters of sandstones and carbonate sediments. A second, vertically much smaller uplift of the region took place at the end of the Carboniferous or the Early Permian. Much of the Carboniferous sediments were removed by erosion, as were remaining Lower Paleozoic deposits. On the crestal area in Israel, north Sinai and Jordan erosion reached the Precambrian basement. SCHANDELMEIER et al. (1997) suggested that the regional uplift was connected with the removal of the late Carboniferous to early Permian ice sheet from much of Gondwana.

A major hiatus connected to erosion and truncation surfaces separated the early Carboniferous unit from overlying ones consisting of massive sandstones and silt and clay beds intercalated which is exposed to the north of Um Bogma, as well as in the Djebel Tih escarpment. This transgressive boundary lies on top of the limestone with a conspicuous carstic surface that is well exposed in Wadi Sacher, just to the west of the village of Um Bogma. In this limestone a marine fauna was found by us (Jochen KUSS and Klaus BANDEL). At Djebel Tih, below the Khashm el Saleh and just to the east of it, the two rich plant occurrences were discovered and exploited in spring 1987 from which the flora was extracted that is here described.

At Djebel Tih the plant bearing Jurassic sequence is overlain by Cretaceous sediments. To the west of St. Catherine monastery the late Paleozoic as well as the Jurassic beds are not preserved, and Cretaceous Kurnub Sandstones overly the Cambrian Um Bogma Formation. The Jurassic series at Djebel Tih consists of about 10 m of sandstone overlain by about 4 m of silt and clay with the flora. Above these 27 m sandstone with silty intercalation follow which end in an irregular ferruginous surface. Above about 70 m usually massive in part reddish to purplish sandstones follow with their top formed by an up to 4 m thick baltic sill. These sandstones are interpreted to reprensent the equivalents to the Kurnub Formation in Jordan and southern Israel which have been deposited by rivers during the early Cretaceous. Above follow marine Cenomanian beds, which become continuously more calcareous to the top. These together with Turonian deposits form most of the slope to the escapement of Djebel Tih with a mostly marine rock series that is about 200 m thick.

III. Material

Annotated species list

Equisetophyta

1. *Equisetum columnare* BRONGNIART (CARPENTIER & FARAG 1948, LORCH 1967b)

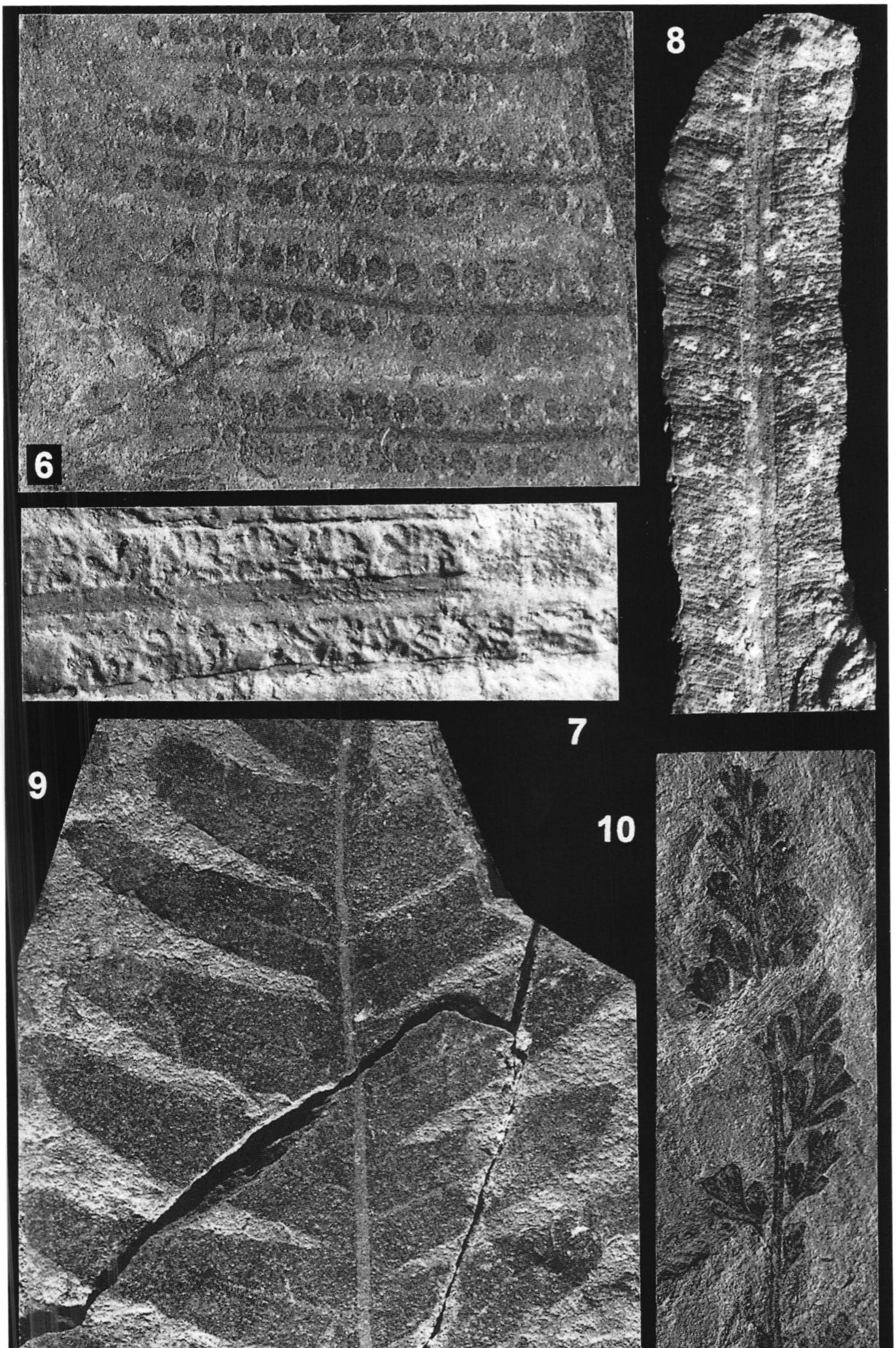
Fig. 6: Fertile pinnae of *Phlebopteris* sp. cf. *P. muensteri,* about 2 mm in width.

Fig. 7: Detail of the fertile pinnae of *Phlebopteris* sp. cf. *P. muensteri* as in Fig.6.

Fig. 8: Pinnules of *Phlebopteris* sp. cf. *P. muensteri* measure, about 5 mm in width.

Fig. 9: Portion of the leaf of *Phlebopteris* sp. cf. *P. muensteri,* about 10 mm long.

Fig. 10: Leaf of *Onychiopsis tenuiloba* LORCH, about 2,5 cm long.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2. *Neocalamites* sp.

Pterophyta

3. *Phlebopteris* sp. cf. *P. muensteri*

4. *Onychiopsis tenuiloba* LORCH (LORCH 1967b)

5. cf. *Sphenopteris fittonii* (LORCH 1967a)

6. *Sellingia microloba* LORCH (LORCH 1967b)

7. *Aspidistes beckeri* LORCH (LORCH 1967b)

8. *Spiropteris* sp. (CARPENTIER & FARAG 1948)

Cycadophyta

9. *Otozamites* sp.

Coniferophyta

10. *Pagiophyllum ramonensis* (LORCH) nov. comb. (LORCH 1967b)

11. *Elatocladus* cf. *E.confertus* (OLDHAM) HALLE

12. *Watsoniocladus ramonensis* (CHALONER & LORCH), SRINIVASAN , (CHALONER & LORCH 1960)

13. *Brachyphyllum* sp. cf. *B. mamillare* LINDLEY et HUTTON (LORCH 1967a, b) and *Brachyphyllum* sp. cf. *B. negevensis* LORCH 1968

14. *Brachyphyllum* sp. cf. *B. LORCHii* RAAB et al. 1986

15. *Classostrobus harrisianus* (LORCH) ALVIN et al. (LORCH 1968)

16. *Hirmeriella* sp.

17. *Masculostrobus* sp.

Incertae sedis

18. Seed, possibly female cone-scales

IV. Comments

(the numbers refer to the annotated species list above)

1. Only two specimens of *Equisetum columnare* BRONGNIART (CARPENTIER & FARAG 1948, LORCH 1967b) were found (fig.1).

2. Two specimens were found of ribbed, equisetalean stem remains (fig.2). They are about 1 cm wide but do not show any nodes, and therefore we simply attribute them to the genus *Neocalamites*. Similar fragments were recorded from the Lower Jurassic of Egypt by ASH (1972).

Fig. 11: Leaf of *Onychiopsis tenuiloba* is 13 mm long.

Fig. 12: Leaf fragment of cf. *Sphenopteris fittonii* (LORCH 1967a), 12 mm in length.

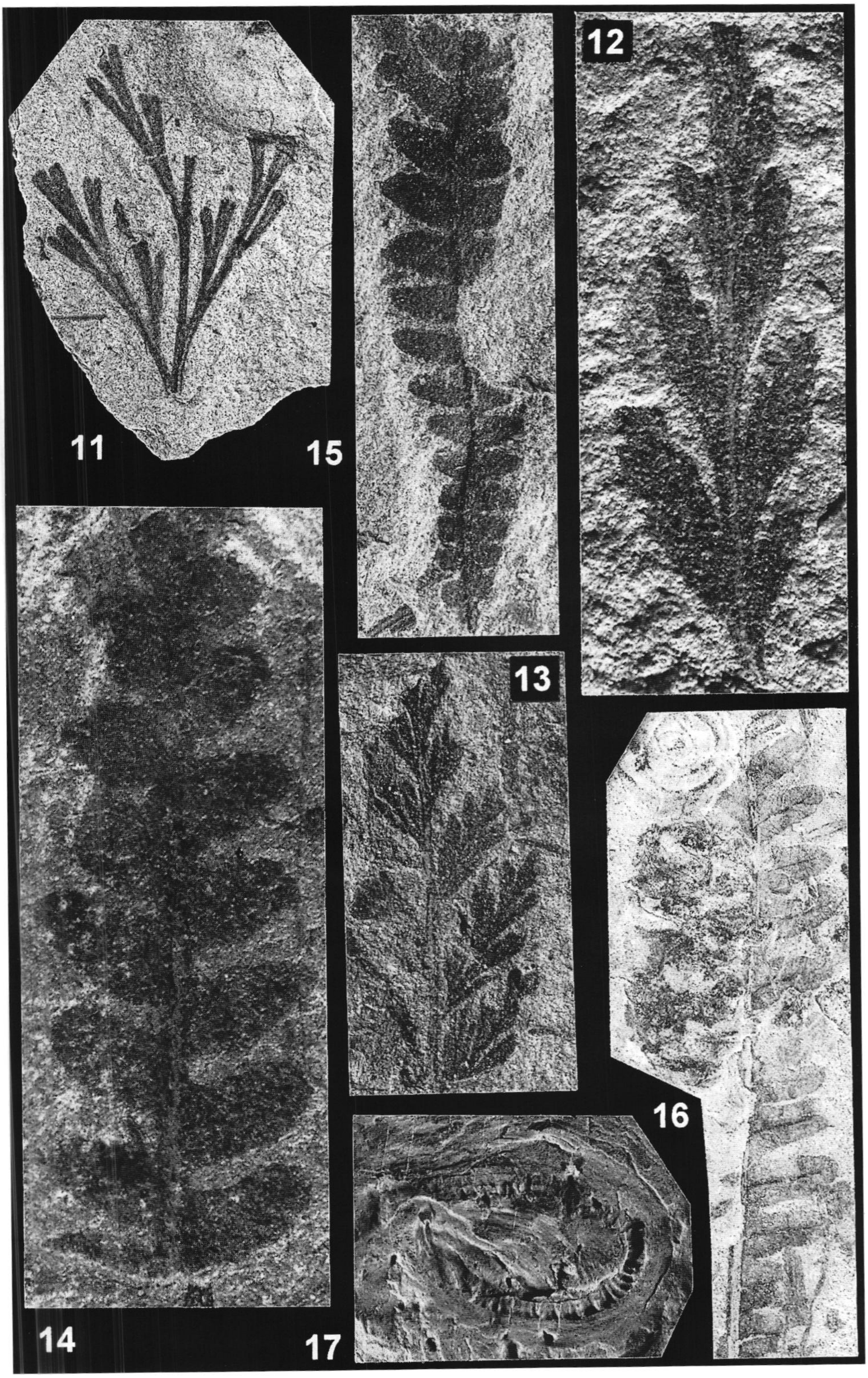
Fig. 13: Leaf fragment of *Onychiopsis tenuiloba,* 14 mm long.

Fig. 14: Leaf fragment of *Sellingia microloba* LORCH, 11 mm long.

Fig. 15: Leaf fragment of *Aspidistes beckeri* LORCH, 22 mm long.

Fig. 16: 6 cm long leaf fragment of *Phlebopteris muensteri* with *Spiropteris* sp. (CARPENTIER & FARAG 1948) at its upper end.

Fig. 17: *Spiropteris* sp., 15 mm wide.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3. *Phlebopteris* remains are very common in the flora from Jebel Tih ranging from leaf bases with several attached pinnae (fig.4) and large sterile (figs.3, 4; fig.9) and fertile (figs.6.7,8) pinnae fragments to detached pinnules. These remains have two things in common; they are only once pinnate and the venation is simple without so-called primary arches and without anastomoses (fig.3). From the area many *Phlebopteris*-like remains have been described but the majority of those are bipinnate with much smaller pinnules than in our material and have a venation with primary arches and many anastomoses. LORCH (1967b) erected the genus *Piazopteris* for these remains, with the type species *Piazopteris branneri* (WHITE) LORCH. This species has been recorded a.o. from the Jurassic of Israel (LORCH 1967b), the Sinai (as *Phlebopteris branneri*, LORCH 1967a), Egypt (as *Phlebopteris branneri*, WEBBER 1961, as *Piazopteris branneri* by ASH 1972), and the early Cretaceous of Libya (EL CHAIR et al. 1995).

Re-examination of LORCH's material from Makhtesh Ramon at the Natural History Museum, London demonstrated that most of his specimens clearly demonstrated the bipinnate character of the larger leaf remains with primary arches and many anastomoses in the venation, but two species labelled as ?*Piazopteris* (V.42640 and V.42641) show leaf remains with longer (> 15 mm) and wider (ca. 4 mm) pinnules without primary arches and anastomoses. These two specimens clearly do not belong to *Piazopteris* but to *Phlebopteris.* The same applies for some of ASH 's specimens from Egypt (V.53920 and V. 53923). It seems that the material formerly described as *Piazopteris branneri* contains two species: the majority of the specimens belong indeed to *Piazopteris* but some specimens belong to *Phlebopteris*. In the material from Djebel Thi, only specimens of *Phlebopteris* occur and these resemble *Phlebopteris muensteri* rather closely, differing only the a slightly denser venation (fig.5). Therefore, we attribute the material to this species with a cf. determination.

The material also contains several specimens that resemble *P.* cf. *muensteri* in gross morphology but do not demonstrate any details of the venation (fig.9). We can only say that these specimens probably belong to this species as well, but they may also belong to a species of the form-genus *Cladophlebis*. If the latter is the case, then it is a *Cladophlebis* species that so far has not been recorded from this region as the pinnules are much longer than that of *C. stricta* (LORCH 1967b).

4. *Onychiopsis tenuiloba* only occurs in rather small fragments (figs.10-11), but these are quite common.

5. The same applies to cf. *Sphenopteris fittonii* (figs.12-13).

6. *Sellingia microloba* is rather rare in the assemblage (figs.14), just as

7. *Aspidistes beckeri* (fig.15).

8. *Spiropteris* sp. (CARPENTIER & FARAG 1948) (figs.16-17).

9. *Otozamites* sp. There are a few fragmentary pinnae (figs.14, 19) that belong undoubtedly to *Otozamites* but that cannot be identified in more detail because of the small size of the fragments and the absence of any cuticular remains. LORCH (1967b) described three *Otozamites* species from Makhtesh Ramon. *O. ramonensis* LORCH has much larger pinnae than in the present material, and the rachis bears numerous round tubercles that are

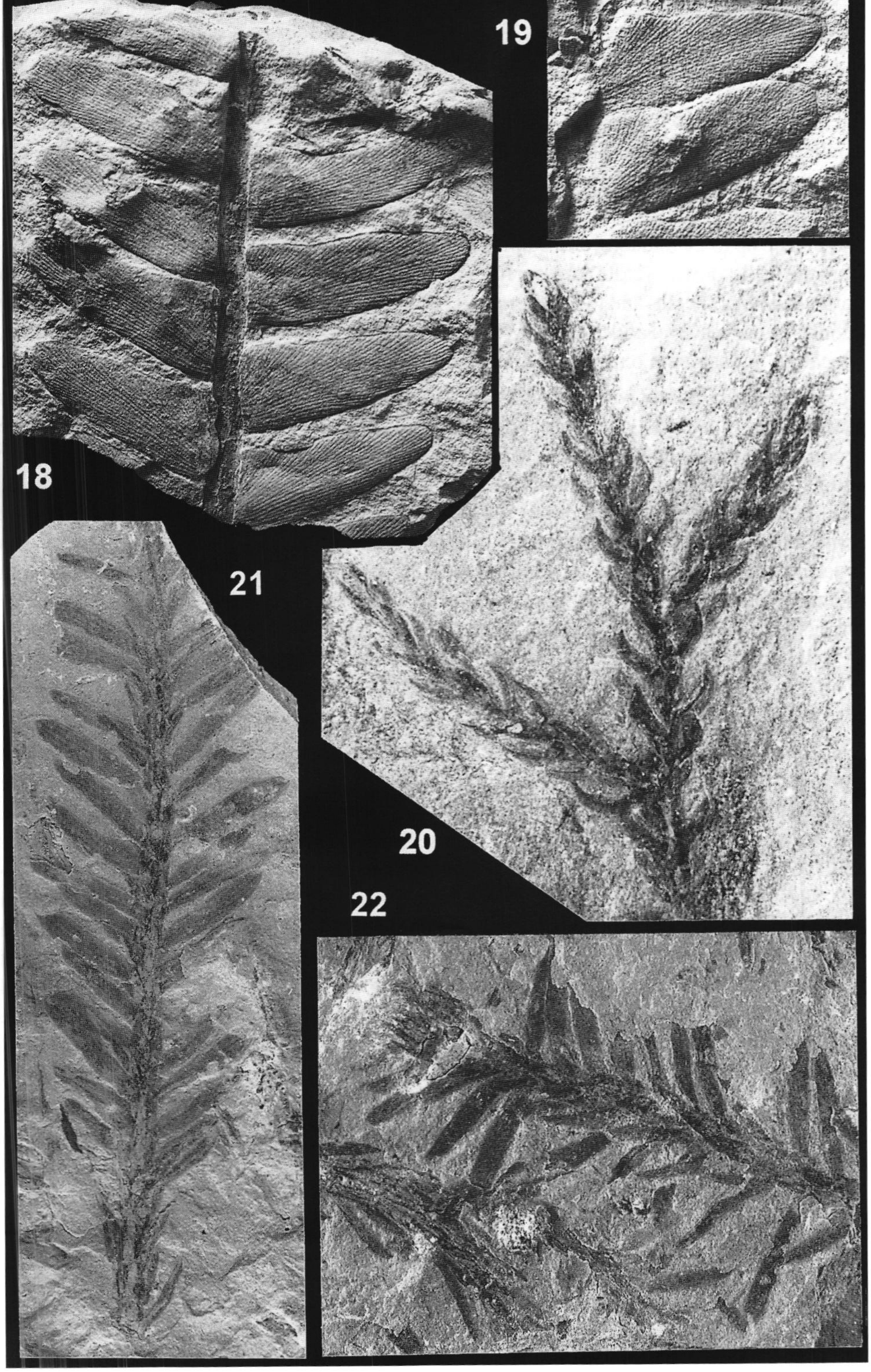
Fig. 18: Fragmented leaf of *Otozamites* sp., 8 cm long.

Fig. 19: Two single pinnules of *Otozamites* sp., each about 1 cm wide.

Fig. 20: *Pagiophyllum ramonensis* (LORCH) nov. comb. (LORCH 1967b), branch 5 cm long.

Fig. 21: *Elatocladus* cf. *E.confertus* (OLDHAM) HALLE, 6 cm long.

Fig. 22: Leaf of *Elatocladus* cf. *E.confertus,* about 3,5 cm long.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absent here. The pinnae of *O.* cf. *mimetes* HARRIS have about the same length (ca. 1 cm) as those of *O. feistmanteli* ZIGNO, but are wider (ca. 6 mm versus 3-4 mm). The material of LORCH's *O. feistmanteli* is the most similar to our material, but at our material the pinnae are usually larger (15-18 mm long and 5-6 mm wide) without very prominent auricles. However, the original *O. feistmanteli* material from the Liassic of Italy has rather small pinnae, also smaller than LORCH's material (only 8 mm long and 2-3 mm wide) with a prominent auricle.

When looking at the other *Otozamites* species from the Liassic of Italy, *O. veronensis* ZIGNO is the most similar as it is characterised by a not very prominent auricle (WESLEY 1974) and pinnae up to 22 mm long and 6 mm wide. *O. parallelus* PHILLIPS and *O. simpsonii* HARRIS from the well-known Middle Jurassic flora of Yorkshire, England is also rather similar both to our *Otozamites* species and to *O. veronensis* (HARRIS, 1969). However, as we do not have any cuticles in our material and these species are mainly characterised by their cuticular remains, we can only designate our specimens as *Otozamites* sp.

10. *Pagiophyllum ramonensis* (LORCH) nov. comb. is here removed from the genus *Elatocladus* in which LORCH (1967b) described it originally as *E. ramonensis*, because according to the emendation of HARRIS (1969) the formgenus *Elatocladus* contains conifer shoots with elongated, dorsiventrally flattened, single-veined leaves. The leaves in *E. ramonensis* are definitely not dorsiventrally flattened and are, therefore, transferred to the form-genus *Pagiophyllum*. The leaves are spirally arranged, and the free part of the leaves is larger than the leaf-base cushion. Hence the attribution to *Pagiophyllum*. Although LORCH (1967b) described the male and female cones of the species, the data are too little to attribute the species to a more natural genus. Similar male cones occur in the present material as well, e.g. on two blocks with *Elatocladus* cf. *E. confertus* (see below).This small-leaved conifer is a rather common element in the present flora (fig.20).

11. *Elatocladus* cf. *E. confertus* (OLDHAM) HALLE. HALLE (1913) made the genus *Elatocladus* for sterile coniferous branches of the radial or dorsiventral type which do not show any characters that permit them to be included in one of the genera instituted for more peculiar forms. Later HARRIS (1969) emended and restricted this form-genus (see under nr. 10), but *E. confertus* still belongs to the genus. It is well-know from e.g. Antarctica (HALLE 1913, GEE, 1989) but the present flora also comprises quite a number of specimens (figs.21-22). The material agrees in all aspects with that described from much younger sediments in Antarctica. The reason for only giving it a cf. attribution is that it occurs often on the same blocks as the previously described species *Pagiophyllum ramonensis*. It is possible that both forms actually belong to one heterophyllous species, but they never have been found attached. Moreover, on a block containing *Elatocladus* cf. *E. confertus* several small male cones occur of the type described by LORCH (1967b) for *Pagiophyllum ramonensis*. But until both forms will be found attached, we describe them under two different form-species (even belonging to different form-genera).

12. *Watsoniocladus ramonensis* (CHALONER et LORCH) SRINIVASAN is represented by several specimens in the collection. This species was originally described as *Cupres-*

Fig. 23: Little branch of *Watsoniocladus ramonensis* (CHALONER et LORCH), 32 mm long.

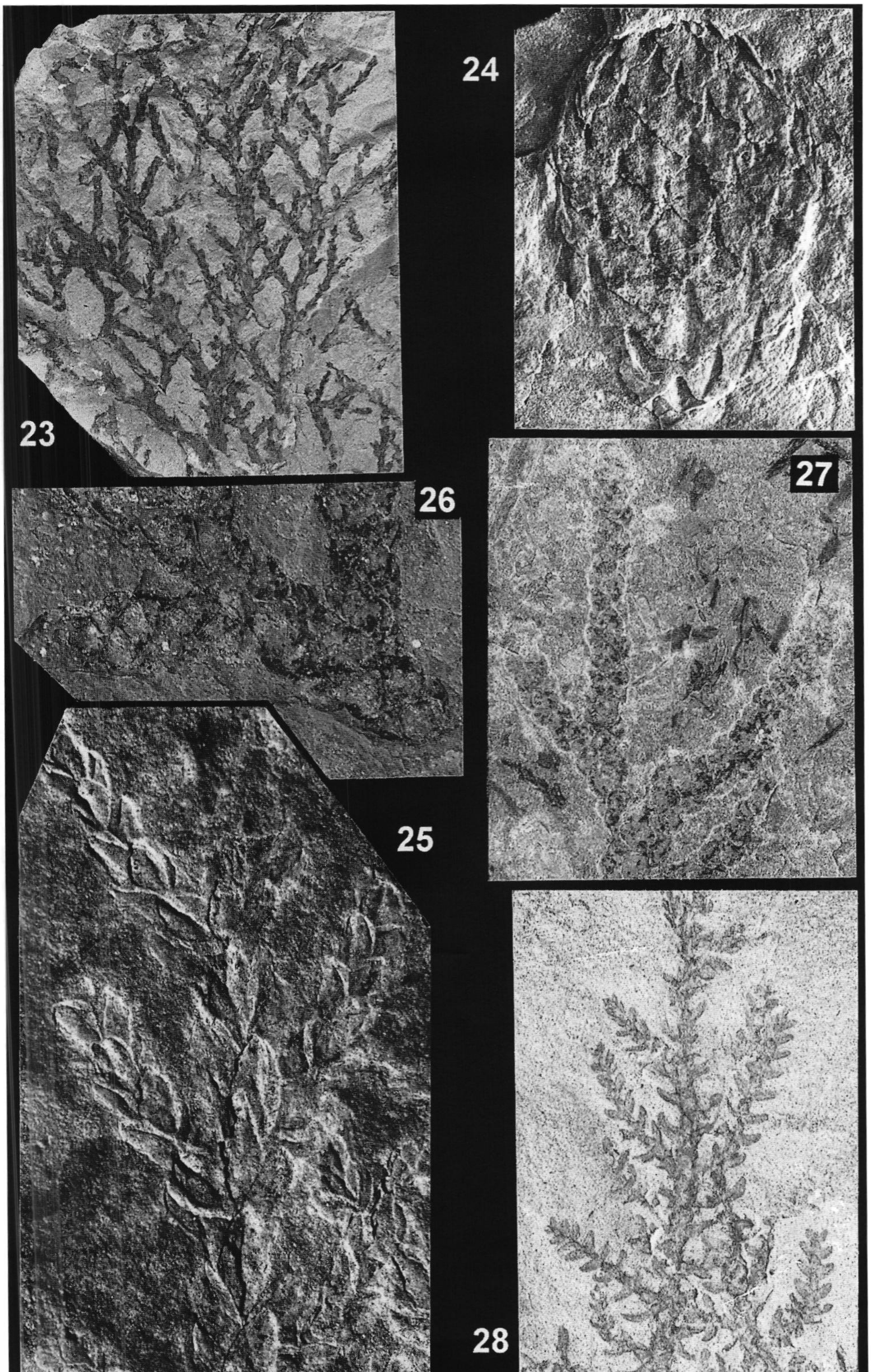
Fig. 24: *Classostrobus harrisianus,* 2 cm in height.

Fig. 25: *Brachyphyllum mamillare* LINDLEY et HUTTON, 15 mm in height.

Fig. 26: Branch of *Brachyphyllum* sp. cf. *B. negevensis* LORCH 1968, about 3 mm wide.

Fig. 27: *Brachyphyllum* sp. cf. *B. negevensis* LORCH 1968, about 3 cm in height.

Fig. 28: Branch of *Brachyphyllum* sp. cf. *B. lorchii* RAAB et al. 1986, s about 3 cm high.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sinocladus ramonensis by CHALONER & LORCH (1960), but SRINIVASAN (1995) transferred all *Cupressinocladus* species with affinities in the fossil conifer family Cheirolepidiaceae to his new genus *Watsoniocladus* including *W. ramonensis*. Its male cones *Classostrobus harrisianus* (LORCH) ALVIN et al. 1978 (figs.24, 29) clearly belong to the Cheirolepidiaceae, and in the present material for the first time the female fructification *Hirmeriella* sp. was found (figs.30, 34, 36).

13. *Brachyphyllum* cf. *B. mamillare* LINDLEY et HUTTON. Quite a few specimens were found that might belong to *B. mamillare* (fig.25) but as the individual leaves are often slightly larger than in the original *B. mamillare* material from the Middle Jurassic of Yorkshire and as no cuticle confirmation could be made, the specimens are provisionally assigned to this taxon. It has also been recorded Northern Sinai and Makhtesh Ramon by LORCH (1967a, b).

Some other specimens that look rather similar, but differ in the slightly larger size of their leaves and especially in the shorter free parts of the leaves are provisionally attributed to *B. negevensis* (figs.26, 27). LORCH (1968) described three new *Brachyphyllum* species from Makhtesh Ramon; from these *B. negevensis* is the most similar, but as no cuticle confirmation could be made, and as the cuticle characters are the most prominent of the species' features, no definite assignment could be made.

The size and shape of the individual leaves are also rather like those of *W. ramonensis,* but the spirally arrangement of the leaves does not allow an attribution to this species. However, it is still possible that all the material might belong to this species (the cuticle descriptions as given by CHALONER & LORCH 1960, and LORCH 1968 are rather similar), and that there is a species variability with shoots with spirally arranged leaves and shoots with decussate leaves. Especially the material here provisionally assigned to *B. mamillare* sometimes shows a more or less decussate leaf arrangement. Judging from the cuticle descriptions of *B. negevensis* and also of the rather similar *B. pulcher* LORCH 1968 these species might very well have belonged to the family Cheirolepidiaceae as well.

14. *Brachyphyllum* sp. cf. *B. lorchii* RAAB et al. 1986 was described from an Upper Jurassic Israeli borehole, West of the Dead Sea. It is characterized by its cuticle, but also by its leaves that point outwards, contrary to all the other *Brachyphyllum* species described from Israel and the Sinai that have appressed leaves. One specimen in the present collection shows this feature as well (fig.28). As it agrees in all main aspects with *B. lorchii* but as we do not know its cuticle, we provisionally assign it to this species.

15. *Classostrobus harrisianus* (LORCH) ALVIN et al. 1978 is the male cone belonging to *Watsoniocladus ramonensis*. It was originally described by LORCH (1968) as *Masculostrobus harrisianus* and subsequently transferred to the genus *Classostrobus* by ALVIN et al. (1978) when that was created for male cones of Cheirolepidiaceous affinities. Six cones of *C. harrisianus* have been found in the present material (fig.29), and although they did not yield any pollen, they fit the description by LORCH (1968) so well that we can attribute them to this species without doubt.

Fig. 29: *Classostrobus harrisianus* (LORCH) ALVIN et al. with about 2 cm long axis.

Fig. 30: Cones of *Hirmeriella* sp., about 5 mm wide.

Fig. 31: Top end of a female cone of cf. *Hirmeriella* sp., 5 mm in width.

Fig. 32: Ovuliform scale of *Hirmeriella* sp., 4 mm wide.

Fig. 33: Female cone of *Hirmeriella* sp., 25 mm high.

Fig. 34: Male cone *Masculostrobus* sp.n., about 6 mm high.

Fig. 35: *Watsoniocladus ramonensis* shoot of 5 cm length with *Hirmeriella* cones.

Fig. 36: Female cone of *Hirmeriella* sp., about 2,5 cm long.

6 mm wide. It tapers gradually unto a more or less acute apex and the seed shows several longitudinal striations. There is no evidence whatsoever to which group of plants this seed may belong. LORCH (1967b) describes a single seed of the same shape and size from Makhtesh Ramon, but no longitudinal striation could be seen in this specimen.

One large, probably female cone-scale has been preserved of a type more or less similar to *Swedenborgia* (see e.g. WEBER 1968). The stalk is ca. 1 cm long and 6 mm wide, it continues in an up to 1.8 cm wide scale that shows six finger-like appendages. The whole scale, including stalk and appendages, shows a fine longitudinal striation. There is no indication of a seed or indeed of a possible place of attachment. *Swedenborgia* is the female fructification belonging to *Podozamites*, a common fossil coniferous genus in the Late Triassic and Jurassic. However, no *Podozamites* leaves have been found in the assemblage, but LORCH (1967b) recorded some isolated leaves from the Jurassic of Israel.

A totally different option is that this is no female cone scale at all, but a small part of a *Phlebopteris* leaf showing the apical end of a petiole where several pinna arms begin.

One possibly female cone scale of the *Araucarites*-type has been found, but it is too badly preserved to attribute it to this genus with certainty. It is ca. 1.2 cm high and 9 mm wide. Its shows the acuminate apex typical for this genus (see e.g. HARRIS 1979), but apart from some faint longitudinal striation no more details could be seen.

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