

## Dkqut cvli tcr j { 'qh'vj g'Dc | gj qy | 'Hqt o cvlqp 'čv'ku'V { r g'ugev lqp. 'Uqwj Y gu' O cuj j cf 'đcugf 'hp' r'npv'b cet qhquku

Hcvgo gj 'Xcgl /Lxcxf k\*. O qj ugp' Cmro gj <sup>4</sup>

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### Cduwcev

Jurassic deposits are well exposed in the Bazehowz area, South west of Mashhad city, East Alborz, Iran. It contains plant macrofossils belonging to eighteen species of eleven genera of various orders such as Equisetales, Filicales, Bennettiales, Cycadales, Corystospermales, Caytoniales, Ginkgoales and Pinales. Two biozones were recognized in the type section of Bazehowz Formation. Biozone I is an assemblage biozone with its lower and upper boundaries identified by first observed occurrence (FOO) and the last observed occurrence (LOO) of *Nilssonia rigida*, *Nilssonia* sp. cf. *N. bozorga* and *Nilssonia feriziensis*. Since there are species from Liassic such as *Nilssonia rigida* and uppermost Liassic such as *Nilssonia feriziensis* and *Nilssonia* sp. cf. *N. bozorga*, a Toarcian age is suggested for this biozone. Biozone II is an interval zone with its lower and upper boundaries identified by FOO of *Klukia exilis* and *Ptilophyllum vasekghansense* and *Coniopteris hymenophylloides* and *Ctenozamites cycadea*, respectively. According to occurrence of *Klukia exilis*, a lowermost Middle Jurassic age is suggested for the lower boundary and based on the occurrence of *Coniopteris hymenophylloides* Aalenian age is considered for upper boundary of Biozone II. On the basis of relative abundance of Filicales (%16.6), Bennettiales (%27.7) and Cycadales it is considered a humid sub-tropical climate for this period of time.

Mg{y qtf u< Alborz, Bazehowz Formation, Biostratigraphy, Jurassic Flora, Iran.

### Kpvt qf wevlqp

Jurassic plant macrofossils have been found at many locations in Iran but existing Jurassic paleobotanical data from Binalud are sparse. Vaez-Javadi and Poulratifi (2002; 2004) described and figured four and eight species from the Rhaetian of Dizbad-e-Bala and the Middle Jurassic of Golmakan (East Alborz), respectively. Saadatnejad *et al.* (2010) described and figured thirty-nine species from the Toarcian-Bajocian of Shandiz (NE Iran). Information from new localities represents important additions to a database used in global phytogeographic and climate studies. Herein, is reported a small florule from the Jurassic of Bazehowz area, SW of Mashhad city, a new fossil plant locality on the Binalud Mountains. The Jurassic period is generally characterized by equable and stable climate and a lack of drastic climatic events. Vakhrameev (1991) and more recently, Rees *et al.* (2000) and Vaez-Javadi (2014) developed palaeoclimatic reconstructions on the basis of paleophytoecological data. Distribution patterns and adaptative mechanisms of plant taxa are interpreted in this framework. Taxonomic studies from new localities provide valuable data for improving climatic and palaeogeographic interpretations. The plant macrofossils described herein were collected from a measured stratigraphic

section in Southeastern Mashhad City, N 36° 3', and E 59° 33' (Fig. 1).

### O cvgt krcđpf O gvj qf u

A total of 74 plant macrofossil samples were collected from the Bazehowz Formation, South West Mashhad city. Material cited in this work (prefixed AJBM; acronym for Allameh, Javadi, Bazehowz and Mashhad) is held in the collections of the Paleontology Laboratory of the Department of Islamic Azad University, Mashhad Branch. They are preserved in siltstone as compressions of variable sized fragments with almost complete pinnules/leaves.

### Nkj qut cvli tcr j { 'čpf 'đkqut cvli tcr j {

The studied section is about 249 m thick without obvious unconformities and consists of successions of conglomerates, sandstones, siltstones, and dark-grey to slightly olive shale bearing plant fossils. There is no evidence of fossils or sediments of marine origin in this section. Three layers contain relatively abundant plant fossils (Fig. 2). Assereto (1966) established the Shemshak Formation based on a type section to the east of Shemshak village. He divided it into four informal members (A to D) represented by: lower sandstone, lower carbonaceous series, upper sandstone and upper

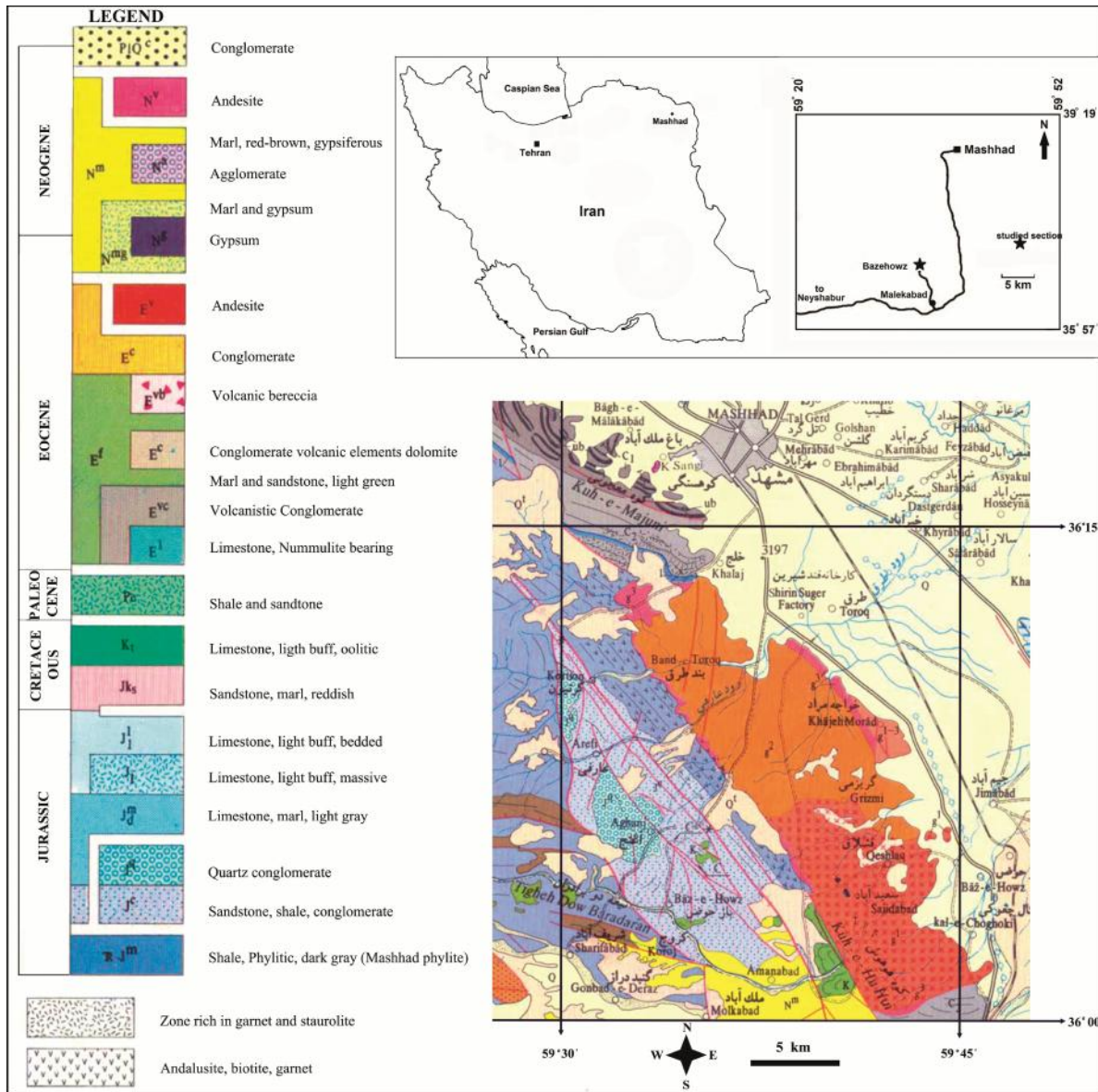


Figure 1. Geological and location map of the studied section (Geological map of Mashhad 1:250000) Source: Afsharharb *et al.* (1986)

carbonaceous series. Fürsich *et al.* (2009a;b) raised the Shemshak Formation to group status. The base of this group rests unconformably on a succession of older strata beginning with the Middle Triassic, Elika Formation. The Dalichai Formation unconformably overlies the Shemshak Group in Central Alborz. Wilmsen *et al.* (2009) studied a Liassic-early Bajocian age of non-marine sequence of the Binalud Mountains which is equivalent to the Jurassic part of the Shemshak Group in Southern Alborz. Based on lithological and sedimentary features, as well as on stratigraphic succession,

three formations are differentiated. These formations from the base upwards are: 1. Arefi Formation, 2. Bazehowz Formation, and 3. Aghounj Aghounj Formation.

The Bazehowz Formation consists of argillaceous silt-fine-sandy silt alternating with large-scale through cross-bedded, medium- to coarse-grained sandstone, pebbly sandstones and fine-grained conglomerates forming beds of up to 10-30 m in thickness (Wilmsen *et al.*, 2009). There are three greenish-grey colored shale consisting plant fossils. The Aghounj Formation is overlying

this formation. Wilmsen *et al.* (2009) did not sharply identify lower and upper boundaries of the Bazehowz Formation. Two biozones were recognized in this section; Biozone I is an assemblage biozone with its lower and upper boundaries identified by FOO (First Observed Occurrence) and LOO (Last Observed Occurrence) of *Nilssonia rigida*, *Nilssonia* sp. cf. *N. bozorga* and *N. feriziensis*.

Since there are species from the Liassic age such as *Nilssonia rigida* (Schweitzer *et al.*, 2000) and uppermost Liassic such as *Nilssonia feriziensis* and *Nilssonia* sp. cf. *N. bozorga* (Fakhr, 1997), a Toarcian age is suggested for this biozone. Biozone II is an interval zone with its lower boundary identified by FOO of *Klukia exilis* and *Ptilophyllum pecten* and upper boundary by FOO of *Coniopteris hymenophylloides* and *Ctenozamites cycadea*. According to occurrence of *Klukia exilis*, a lowermost Middle Jurassic age (Schweitzer *et al.*, 2009) is suggested for the lower boundary and based on the occurrence of *Coniopteris hymenophylloides* an Aalenian age is considered for the upper boundary of Biozone II.

#### Systematic palaeobotany

The flora contains eighteen species within eleven genera from various orders such as Equisetales, Filicales, Bennettitales, Cycadales, Corystospermales, Caytoniales, Ginkgoales and Pinales. The flora from this locality is here reported for the first time.

Division: Sphenophyta

Class: Sphenopsida

Order: Equisetales

**Genus:** *Equisetites* Sternberg, 1833

*Equisetites beanii* (Bunbury, 1851) Seward, 1894 emend. Harris, 1961 (Plate 5, Fig. 7b)

Class: Leptosporangiopsida

Order: Gleicheniales

Family: Dicksoniaceae

**Genus:** *Coniopteris* Brongniart, 1849

*Coniopteris hymenophylloides* (Brongniart, 1828) Seward, 1900 (Plate 1, Figs. 1, 2, 5)

Order: Filicales

Family: Schizaeaceae

**Genus:** *Klukia* Raciborski, 1890

*Klukia exilis* (Phillips, 1829) Raciborski, 1890 (Plate 1, Figs. 6, 7)

Division: Pteridospermophyta

Order: Caytoniales

Family: Caytoniaceae

**Genus:** *Caytonia* Thomas, 1925

*Caytonia* sp. (Plate 4, Fig. 4)

Order: Corystospermales

Family: Incertae Sedis

**Genus:** *Ctenozamites* Nathorst, 1886 emend. Harris, 1964

*Ctenozamites cycadea* (Berger, 1832) Schenk, 1887 (Plate 4, Figs. 1, 2)

Division: Cycadophyta

Order: Cycadales

**Genus:** *Nilssonia* Brongniart, 1825

*Nilssonia* sp. cf. *N. bozorga* Barnard & Miller, 1976 (Plate 3, Fig. 1)

*Nilssonia feriziensis* Fakhr, 1977 (Plate 2, Figs. 1, 2; Plate 3, Figs. 5, 6)

*Nilssonia rigida* Schweitzer, Kirchner & van Konijnenburg-van Cittert, 2000 (Plate 2, Figs. 4, 5)

*Nilssonia* sp. cf. *N. tazarensis* (Sadovnikov, 1991) Schweitzer, Kirchner & van Konijnenburg-van Cittert, 2000 (Plate 2, Fig. 2)

*Nilssonia undulata* Harris, 1932 (Plate 2, Fig. 3; Plate 3, Fig. 3)

Division: Uncertain /? Cycadophyta

Order: Bennettitales

**Genus:** *Otozamites* Braun, 1842

*Otozamites harrisianus* (Kilpper, 1968) Schweitzer & Kirchner, 2003 (Plate 5, Fig. 3)

Genus: *Ptilophyllum* Morris, 1840

*Ptilophyllum pecten* (Phillips, 1829) Morris, 1841 emend. Harris, 1969 (Plate 3, Fig. 2; Plate 5, Figs. 4, 6)

*Ptilophyllum harrisianum* Kilpper 1968 (Plate 5, Fig. 1)

*Ptilophyllum vasekgahense* Barnard & Miller, 1976 (Plate 5, Fig. 2)

**Genus:** *Williamsonia* Carruthers, 1870 emend. Harris, 1969

*Williamsonia* sp. (Plate 5, Fig. 7b)

Division: Ginkgophyta

Order: Ginkgoales

**Genus** *Ginkgoites* Seward, 1900

*Ginkgoites parasingularis* Kilpper, 1971 (Plate 3, Fig. 4; Plate 5, Fig. 5)

Division: Pinophyta/ Coniferophyta

Class: Pinopsida/ Coniferopsida  
 Order: Pinales/ Coniferales

*Podozamites distans* (Presl, 1838) Braun, 1843  
 (Plate 4, Fig. 3)

Genus: *Podozamites* Braun, 1843

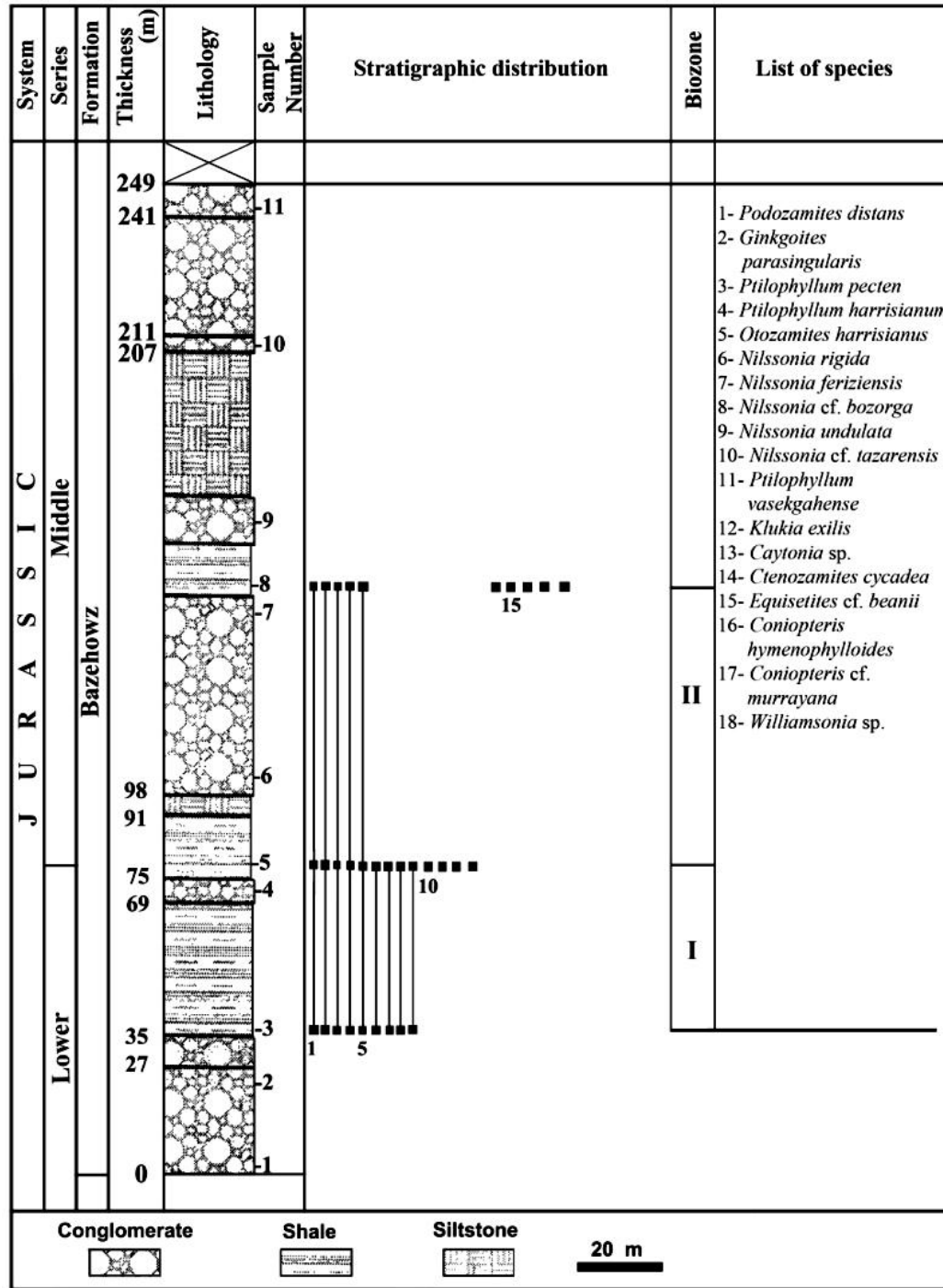


Figure 2. Biostratigraphy of the fluvial Bazehowz Formation

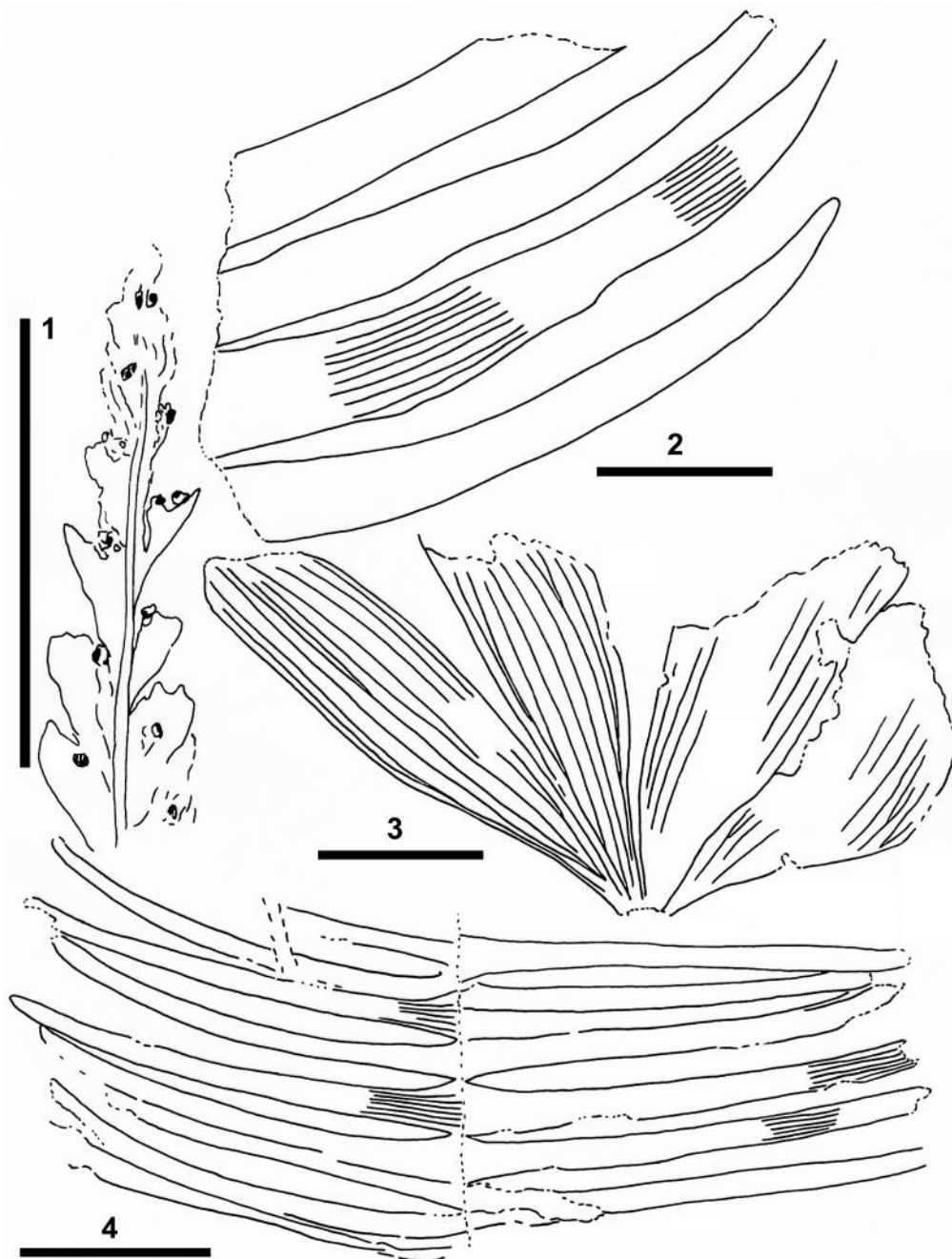


Figure 3. 1. *Coniopteris* sp. cf. *C. murrayana*, Fig. 2. *Nilssonia ferziensis*, Fig. 3. *Ginkgoites parasingularis*, 4. *Nilssonia rigida*. Scale bars= 1 cm.

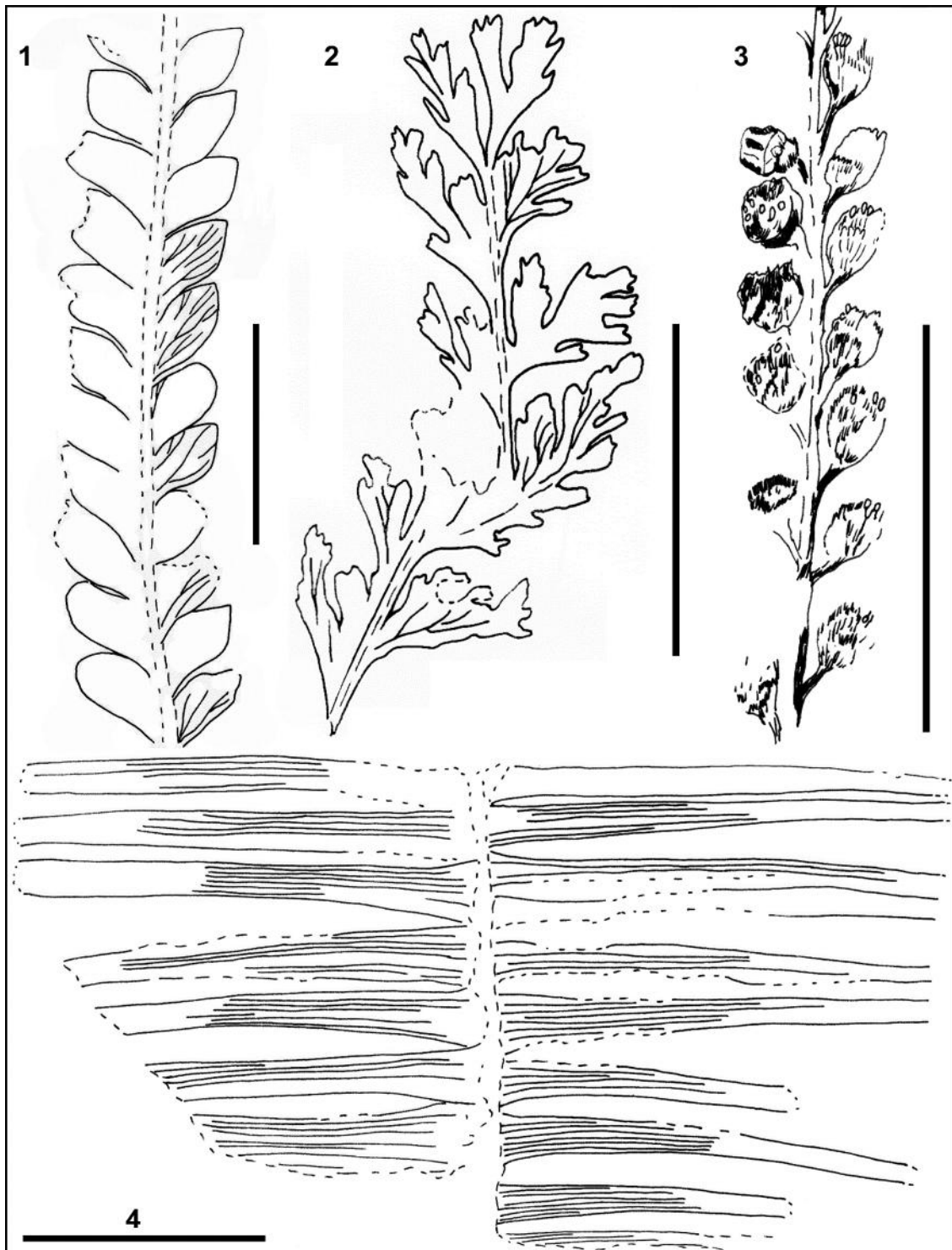


Figure 4. 1. *Ctenozamites cycadea*, 2. *Coniopteris hymenophylloides*, 3. *Caytonia* sp., 4. *Nilssonia rigida*. Scale bars= 1cm

#### Geographic and stratigraphic distribution of taxa

Floristic association described here is widespread in the Central-East Alborz Mountains, Kerman

Basin and Tabas areas in the early Middle Jurassic. Similar plant macrofossil assemblages have been distinguished from the Shemshak Group in the Alborz Mountains at Tazareh, Zirab, Sangrud,





Table 2. Stratigraphic range and palaeogeographic distribution of the plant macrofossils in the Bazehowz Formation throughout the world

Occurrences	Authors	Age	Species	<i>Equisetites heanii</i>	<i>Coniopteris hymenophylloides</i>	<i>Coniopteris murrayana</i>	<i>Klukia exilis</i>	<i>Ctenozamites cycadea</i>	<i>Nilssonia Undulata</i>	<i>Ptilophyllum pecten</i>	<i>Ptilophyllum vaseghahense</i>	<i>Podozamites distans</i>
Talbragar (New South Wales)	Walkom (1921), White (1981)	Jurassic		*								*
Kawhia Harbour, Curio Bay (New Zealand)	Edwards (1934), Aber (1917)	Jurassic		*								
Montana (U.S.A)	Lapusha and Miller (1985)	E. Cretaceous		*								
Höör, Fålsjö (Scania, Sweden)	Nahors (1886, 1878), Halle (1908), Auevs (1919)	Rhaetian- E. Jurassic		*				*				*
Scoreby Sound (E-Greenland)	Harris (1932)	E.-M. Jurassic							*			
Yorkshire (England)	Brongniart (1829), Bunbury (1851), Zigno (1856), Phillips (1829, 1875), Seward (1898, 1900), Thomas (1912), Harris (1946, 1961, 1964, 1969, 1979), van Konijnenburg-van Cittert (2008)	Middle Jurassic		*	*	*	*	*		*		*
Poland	Rachorski (1890, 1894)	M. Jurassic		*			*					
Frankens (Germany)	Berger (1832), Presl (1838), Braun (1843)	Rhaetian-M. Jurassic						*				*
Bassin de la Loire (France)	Saporta (1872, 1891), Corsin (1950)	Rhaetian- E. Jurassic		*				*				
Tuar-Kyr (Turkmenistan)	Duan (1987)	Middle Jurassic		*								
Dahana-i-Tor, Karkar, Ishpushita Afghanistan	Seward (1912), Sitolev (1940), Jacob & Shukla (1953), Benda (1964)	Middle Jurassic		*	*	*	*				*	*
Fergana (E. Kazakhstan)	Brick (1957, 1953)			*	*	*						
Tkvarchelian (Transcaucasia)	Prynada (1933), Delle (1967)	Middle Jurassic		*		*						
Kansu, Hupoh, Shensi, W. Hubei (China)	Sze (1933, 1949), Lee (1955), Wu et al. (1980)	E.-M. Jurassic		*								
Kamenka, Emba region (Russia)	Thomas (1911), Prynada (1938), Stanislawski (1957)	Jurassic		*	*	*	*					
Mongolia	Sze (1952)	Jurassic		*								
Quang-Nam, Hongay (Vietnam)	Vozeniz-Serra & Franceschi (1999)	Rhaetian										*
Työsen (Korea)	Kawasaki (1926)	E. Cretaceous		*								
Kuwajima (Japan)	Yokoyama (1890, 1906)	Jurassic		*								
Isikawa (Daidō & Teori Series) Japan	Kawasaki (1926), Oishi (1940), Endo (1952)	M. Jurassic- E. Cretaceous		*			*					



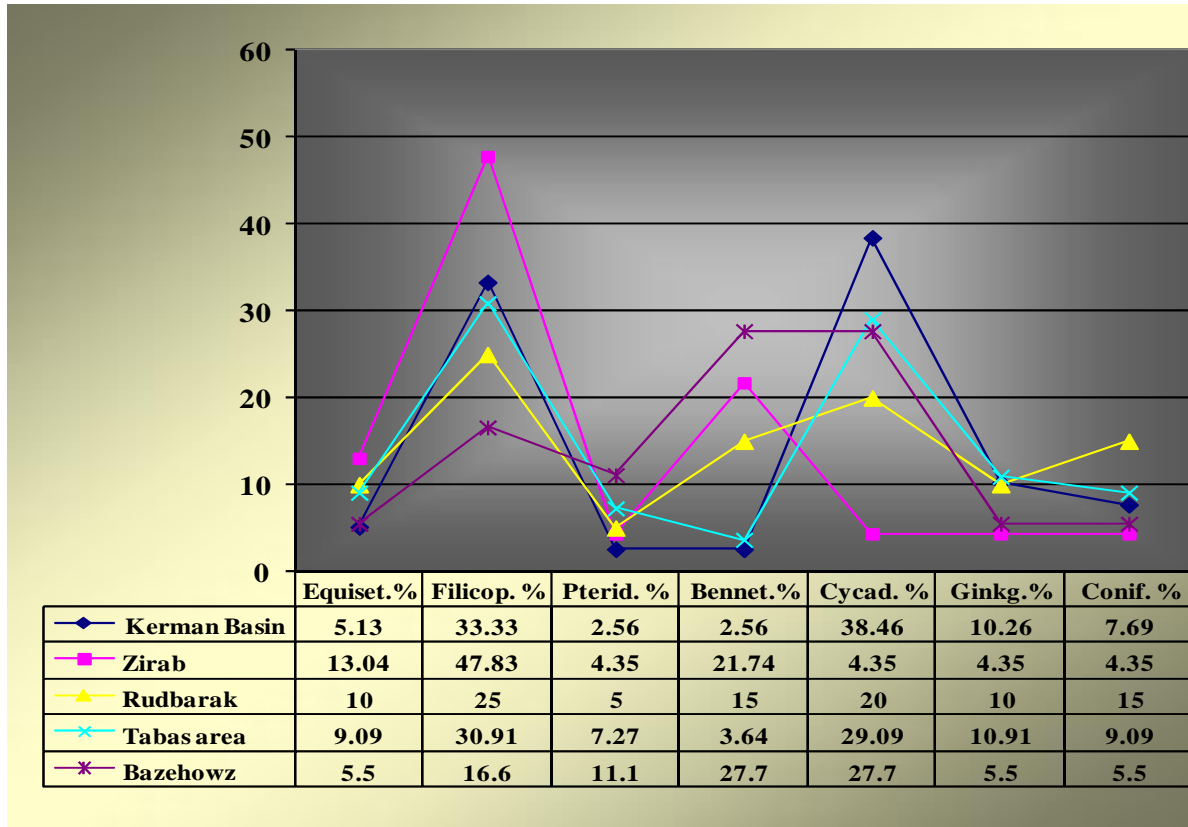


Figure 5. Comparison chart of distribution of various taxa during the Middle Jurassic in five localities in Iran (Alborz, Kerman Basin and Tabas area)

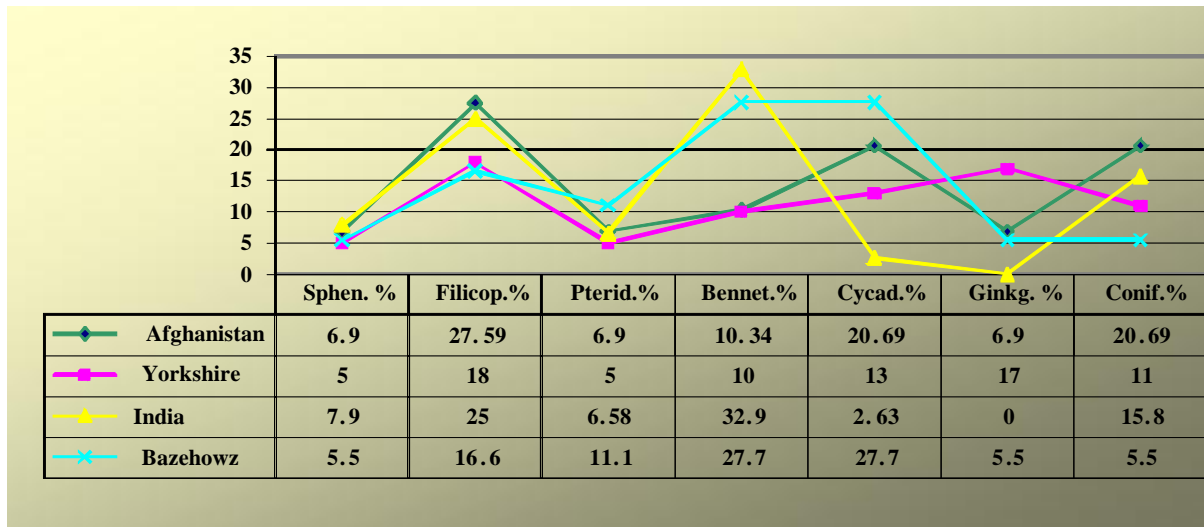


Figure 6. Comparison chart of distribution of various taxa during the Middle Jurassic in Afghanistan, Yorkshire (England), India and Bazehowz

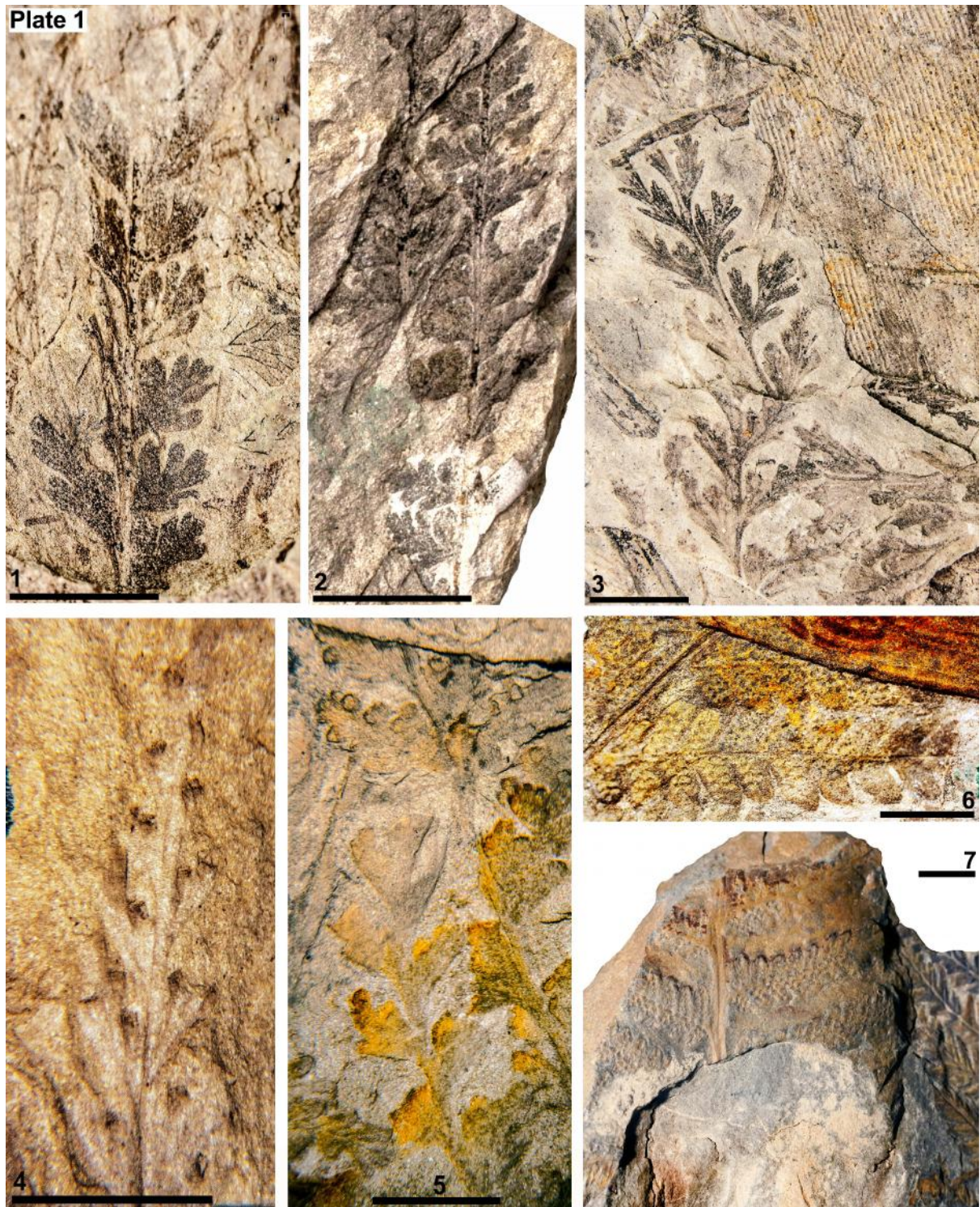


Plate 1. Figs. 1, 2, 5- *Coniopteris hymenophylloides*; Figs. 3, 4- *Coniopteris* sp. cf. *C. murrayana*; Figs. 6, 7- *Klukia exilis*. Scale bars = 1 cm.





Plate 2. Figs. 1. *Nilssonia feriziensis*; Fig. 2. *Nilssonia* sp. cf. *N. tazarensis*; Fig. 3. *Nissonia undulata*; Figs. 4, 5. *Nilssonia rigida*. Scale bars= 1 cm





Plate 3. Fig. 1. *Nilssonia* sp. cf. *N. bozorga*; Fig. 2. *Ptilophyllum pecten* ; Fig. 3. *Nilssonia undulata*; Fig. 4. *Ginkgoites parasingularis*; Figs. 5, 6. *Nilssonia feriziensis*. Scale bars= 1 cm.





Plate 4. Figs. 1, 2. *Ctenozamites cycadea*; Fig. 3. *Podozamites distans*; Fig. 4. *Caytonia* sp.; Fig. 5. *Ptilophyllum pecten*; Fig. 6. *Nilssonia rigida*. Scale bars= 1 cm.



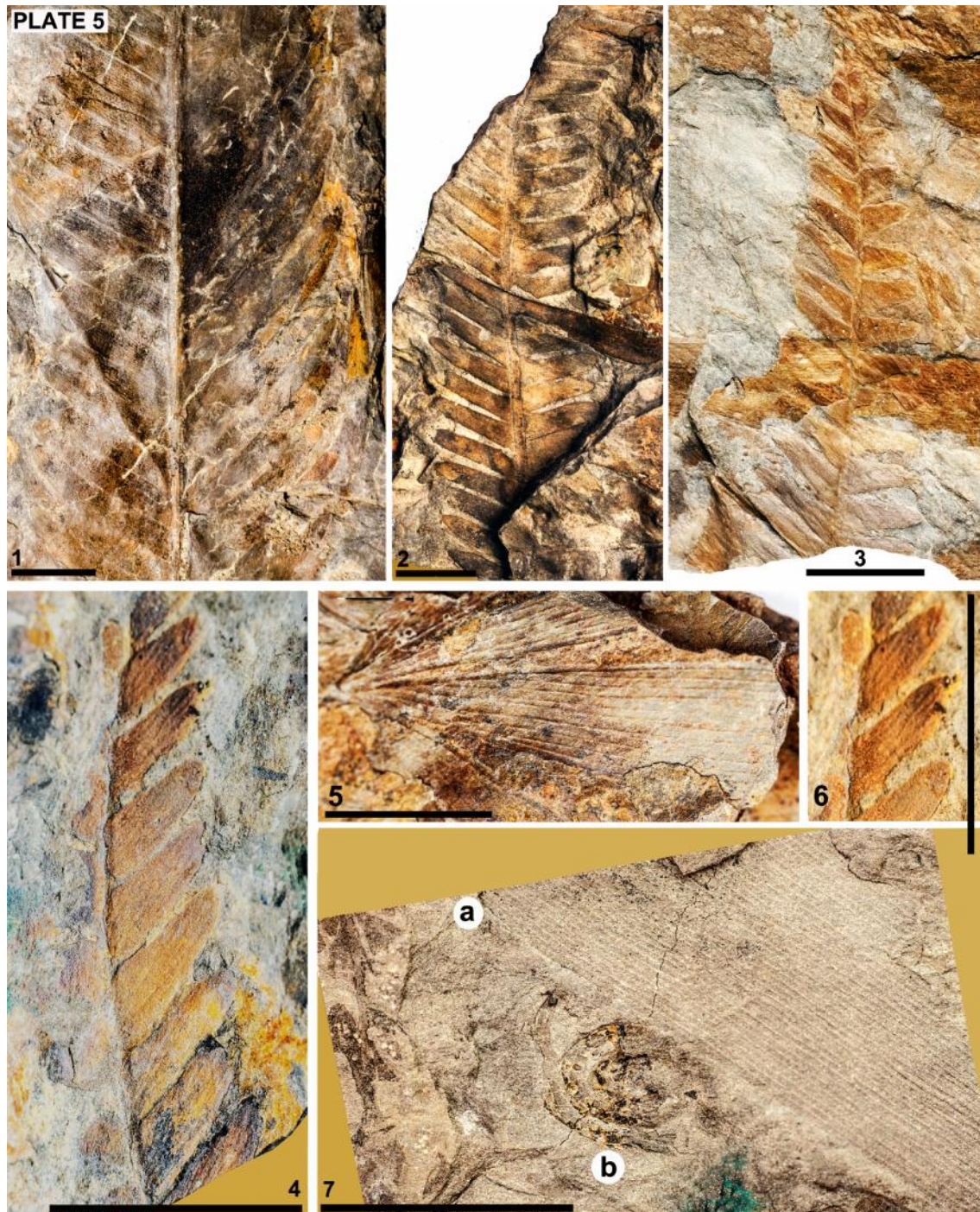


Plate 5. Fig. 1. *Ptilophyllum harrisianum*, Fig. 2. *Ptilophyllum vasekgahense*, Fig. 3. *Otozamites harrisianus*, Figs. 4, 6. *Ptilophyllum pecten*, Fig. 5. *Ginkgoites parasingularis*, Fig. 7a. *Equisetites* sp. cf. *E. beanii*, Fig. 7b. *Williamsonia* sp. Scale bars= 1 cm.

Results of this study indicated that Filicophyta and Cycadophyta were relatively quite abundant. Therefore, the climate was humid and sub-tropical to tropical in this area.

### Conclusion

In this study, new data have been provided from the Bazehowz Formation, Binalud, east of Iran. Jurassic deposits in this section contains plant macrofossils belonging to eighteen species within

eight genera of various orders such as Equisetales, Filicales, Bennettitales, Cycadales, Corystospermales, Caytoniales, Ginkgoales and Pinales. Two biozones were recognized in this section; Biozone I is an assemblage biozone with its lower and upper boundaries identified by FOO and LOO of *Nilssonia rigida*, *Nilssonia* sp. cf. *N. bozorga* and *N. feriziensis*. Since there are species from Liassic such as *Nilssonia rigida* and uppermost Liassic such as *Nilssonia feriziensis* and *Nilssonia* sp. cf. *N. bozorga*, a Toarcian age is suggested for this biozone. Biozone II is an interval zone with its lower boundary identified by FOO of *Klukia exilis* and *Ptilophyllum vasekgahense* and

upper boundary by FOO of *Coniopteris hymenophylloides* and *Ctenozamites cycadea*. According to occurrence of *Klukia exilis*, a lowermost Middle Jurassic age is suggested for the lower boundary and based on the occurrence of *Coniopteris hymenophylloides*, Aalenian age is considered for the upper boundary of Biozone II. It is noteworthy that variety and relative abundance of the species of Genus *Nilssonia* (five species) and species of Order Bennettitales (five taxa), as a macrophyllous cycadophyte, was high within the Bazehowz area. Furthermore, on the basis of occurrence of three species of ferns, a humid subtropical climate is suggested for this period of time.

## References

- Afshar Harb, A., Aghanabati, A., Madjidi, B., Alavi Tehrani, N., Shahrabi, M., Davodzadeh, M., Navai, I., 1986. Mashhad map no. K-4. Geological Survey of Iran, Tehran.
- Alavi, M., Barale, G., 1970. Étude préliminaire de la flore de la formation de Shemshak dans la région de Djam. Bulletin de la Société Linnean de Lyon, 39 (8): 241-252
- Antevs, E., 1919. Die liassische Flora des Hörsandsteins. Kungliga Svenska Vetenskapsakademiens Handlingar, 59 (8): 1-71.
- Arber, E.A.N., 1917. The earlier Mesozoic floras of New Zealand. Palaeontological Bulletin of the New Zealand Geological Survey, 6: 1-80.
- Assereto, R., 1966. The Jurassic Shemshak Formation in Central Elburz (Iran): Rivista Italiana di Paleontologia e Stratigrafia. 72 (4): 1133-1182.
- Barnard, P.D.W., Miller, J.C., 1976. Flora of the Shemshak Formation (Elburz, Iran), Part 3: Middle Jurassic (Dogger) plants from Khatumbargah, Vasekgah and Imam Manak. Palaeontographica B, 155: 31-117.
- Benda, L., 1964. Die Jura-Flora aus der Saighan-Serie Nord-Afghanistans. Beihefte zum Geologischen Jahrbuch, 70: 99-152.
- Berger, A.C., 1832. Die Versteinerungen der Fischer und Pflanzen im Sandsteine der Coburger Gegend. 30 pp., 4 pls. Coburg.
- Braun, C.F.W., 1843. Beiträge zur Urgeschichte der Pflanzen. Beiträge zur Petrefacten-Kunde, 6 (7): 1-46.
- Brick, M.I., 1937. La flore Mésozoïque du Ferghana Méridional, II. Fougères (fin) Equisétinées. Transactions of the Geological Trust of the Central Asia, Tashkent, 3: 1-75. (In Russian with French summary)
- Brick, M.I., 1953. Mesozoic Flora of the East-Ferghana Coal Basin. Ferns. Trudy VSEGEL, Gosgeolisdat, 1-112. (In Russian)
- Brongniart, A., 1828-1838. Histoire des végétaux fossiles, ou recherches botaniques et géologiques sur les végétaux renfermés dans les diverses couches du globe. v. 1- (1828-1837): XII + 488 pp; v. 2- (1837-1838): 72 pp. Paris
- Bunbury, C.J.F., 1851. On some fossil plants from the Jurassic strata of the Yorkshire Coast. Quarterly Journal of Geological Society of London, 7: 179-194.
- Corsin, P., 1950. Les divisions paléontologiques du Stéphanien du Bassin de la Loire. Comptes Rendus Académie des Sciences, 230.
- Corsin, P., G., Stampfli, 1977. La formation de Shemshak dans l'Elburz oriental (Iran) flore - stratigraphie - paléogéographie. Geobios, 10: 509-571.
- Delle, G.V., 1967. The Middle Jurassic Flora of the Tkvarchelian coal-basin (Transcaucasia). Paleobotanika, 6: 51-132.
- Duan, S., 1987. The Jurassic flora of Zhaitang, Western Hills of Beijing. Department of Geology, University of Stockholm & Department of Palaeobotany, Swedish Museum Natural History, 95 pp.
- Edwards, W.N., 1934. Jurassic plants from New Zealand. The Annals Magazine and Nature History, 13 (10): 81-109.
- Endo, S., 1952. *Klukia* remains newly found in Japan. The Palaeobotanist, 1: 165-167.
- Fakhr, M.S., 1977. Contribution à l'étude de la flore Rhéto - Liasique de la formation de Shemshak de l'Elbourz (Iran): Mémoire de Section de Science, 5, 178 pp., Paris.
- Fürsich, F.T., M., Wilmsen, K., Seyed-Emami, 2009a. Lithostratigraphy of the Upper Triassic-Middle Jurassic Shemshak Group of northern Iran. Geological Society London, Special Publications, 312: 120-160.
- Fürsich, F.T., Wilmsen, M., Seyed-Emami, K., Majidifard, M.R., 2009b. The Mid-Cimmerian tectonic event (Bajocian) in



- the Alborz Mountains, Northern Iran: evidence of the break-up unconformity of the South Caspian Basin. Geological Society London, Special Publications, 312: 189-203.
- Halle, T.G., 1908. Zur Kenntnis der mesozoischen Equisetales Schwedens. Kungliga Svenska Vetenskapsakademiens Handlingar, 43: 1-56.
- Harris, T.M., 1932. The fossil flora of Scoresby Sound East Greenland, Part 2: Description of seed plants incertae sedis together with a discussion of certain Cycadophyte cuticle. Meddelelser om Grönland, 85 (3): 1-112.
- Harris, T.M., 1946. Notes on the Jurassic flora of Yorkshire, 25-27. 25 *Stenopteris nitida* sp. n., 26 *sphenopteris metzgerioides* sp. n., 27 *Pseudoctenis herriesi* sp. n. The Annals and Magazine of Natural History, 11 (12): 820-835.
- Harris, T.M., 1961. The Yorkshire Jurassic Flora, I. Thallophtya-Pteridophyta. British Museum (Natural History), 212 pp. London.
- Harris, T.M., 1969. The Yorkshire Jurassic flora. III. Bennettitales. British Museum (Natural History), 186 pp., London.
- Harris, T.M., 1979. The Yorkshire Jurassic Flora, V. Coniferales. British Museum (Natural History), 166 pp. London.
- Jacob, K., Shukla, B.N., 1955. Jurassic plants from the Saighan Series of northern Afghanistan and their palaeoclimatological palaeogeographical significance. Memoirs of the Geological Survey of India, Palaeontographica Indica, new series, 33 (2): 1-64.
- Kawasaki, S., 1926. Addition to the older Mesozoic plants in Korea. Bulletin of Geological Survey of Chosen (Korea), Keizyo, 4 (2): 1-35.
- Kilpper, K., 1964. Über eine Rät/Lias-Flora aus dem nördlichen Abfall des Albus Gebirges in Nord-Iran. Teil I: Bryophyta und Pteridophyta. Palaeontographica B, 114: 1-78.
- Kilpper, K., 1968. Einige Bennettiteen-Blätter aus dem Lias von Karmozd-Zirab. Journal of the Linnean Society (Botany), 61: 129-135.
- Kilpper, K., 1971. Über eine Rät/Lias-Flora aus dem nördlichen Abfall des Albus-Gebirges in Nord-Iran. Teil II: Ginkgophyten-Belaubungen: Palaeontographica B, 133 (4-6): 89-102.
- Lapasha, C.A., Miller, C.N., 1985. Flora of the Early Cretaceous Kootenai Formation in Montana, Bryophytes and Tracheophytes excluding conifers. Palaeontographica B, 196 (4-6): 111-145.
- Lee, H.H., 1955. On the Age of the Yungkang Series of the Tantung coalfield in North Shansi. Acta Palaeontologica Sinica, 3: 25-46.
- Nathorst, A.G., 1878. Beiträge zur fossilen Flora Schwedens. Über winige fossile Pflanzen von Palsjö in Schonen. E. Schweiz. Verlag., 1-34.
- Nathorst, A.G., 1886. Om floran Skanes kolförande Bildningar. I. Floran vid Bjuf. Sveriges Geologiska Undersökning, 85: 85-131.
- Ôishi, S., 1940. The Mesozoic flora of Japan. Journal of Faculty of Science, Hokkaido Imperial University, 5: 123-480.
- Phillips, J., 1829. Illustrations of the geology of Yorkshire, or a description of the strata and organic remains of the Yorkshire Coast: Thomas Wilson & sons, York, xvi + 192 pp.
- Presl, K. in Sternberg, C. von, 1838. Versuch einer geognostisch-botanischen Darstellung der Flora der Vorwelt, Part 8, Leipzig & Prague, vii+ 71 pp.
- Prynada, B., 1933. Jurassic plants from the Tkvarcheli carboniferous Basin in Transcaucasia. Transactions of the Geological and Prospecting Service of U.S.S.R., Moscow, 261: 1-40. (In Russian)
- Prynada, B., 1938. Jurassic Flora of the Emba Region. Problems of Palaeontology, 4: 363-404. (In Russian)
- Raciborski, M., 1890. Über die Osmundaceen und Schizaceen der Juraformation. Botanik Jahrbuch, 13: 1-9.
- Raciborski, M., 1894. Flora Kopalna ogniotrwalych Glinek Krakowskich. Pamietnik Akademii Umiejtnosci, 18: 143-243.
- Rees, P.Mc.A., Ziegler, A.M., Valdes, P.J., 2000. Jurassic phytogeography and climates: new data and modern comparisons. In: Huber, B.T.,
- Macleod, K.G., Wing, S.L. (Eds.), Warm Climates in Earth History. Cambridge University Press, Cambridge, pp. 297-318.
- Saadatnejad, J., Ghaderi, A., Naeemi-Ghasabian, N., 2010. Study and presentation of Toarcian-Bajocian plant macrofossils of Gorakhk- Shandiz region, NE of Iran. Sedimentary Facies, 2 (2): 173-203.
- Sadovnikov, G., 1976. The Mesozoic flora of Alborz and central Iran and its stratigraphic importance: National Iran Steel Company of Iran, Tehran, 118 pp., 13 pls.
- Sadovnikov, G.N., 1984. Die Flora der Kohleformation des Elburs. III. Gheshlagh-Flora. Atlas. Akademii Nauk SSSR, Institute of Geology, N 839-84 Dep., 83 pp. (In Russian)
- Sadovnikov, G.N., 1991. On some gymnosperms from the late Triassic of North Iran. Paleontological Journal, 4: 95-106. (In Russian)
- Saporta, G., 1872-1873. Paléontologie française ou description de fossils de la France, Plantes Jurassiques. I. Algues, equisetacées, characées, fougères. Pp. 1-432, pls. 1-60 (1872); pp. 433-506, pls. 61-70 (1873).
- Saporta, G., 1886-1891. Paléontologie française ou description de fossils de la France, Plantes Jurassiques. III, IV. Pp. 1-177, pls. 1-22 (1886); pp. 178-208, pls. 23-28 (1888); pp. 209-272, pls. 29-40 (1889); pp. 273-354, pls. 41-52 (1890);

- pp. 355-548, pls. 53-74 (1891).
- Schenk, A., 1887. Fossile Pflanzen aus der Albours-Kette. *Bibliotheca Botanica*, 6: 1-12.
- Schweitzer, H.J., Kirchner, M., 1995. Die rhäto-jurassischen Floren des Iran und Afghanistans. 8. Ginkgophyta. *Palaeontographica B* 237 (1-3): 1-58.
- Schweitzer, H. J., Kirchner, M., 1996. Die rhäto-jurassischen Floren des Iran und Afghanistans. 9. Coniferophyta. *Palaeontographica B*, 238 (4-6): 77-139.
- Schweitzer, H.-J., Kirchner, M., 1998. Die rhäto-jurassischen Floren des Iran und Afghanistans. 11. Pteridospermophyta und Cycadophyta I. Cycadales. *Palaeontographica B*, 248 (1-3): 1-85.
- Schweitzer, H.-J., Kirchner, M., 2003. Die rhäto-jurassischen Floren des Iran und Afghanistans 13. Cycadophyta. III. Bennettitales. *Palaeontographica B*, 264 (1-6): 1-166.
- Schweitzer, H.-J., van Konijnenburg-van Cittert, J.H.A., van Der Burg, J., 1997. The Rhaeto-Jurassic flora of Iran and Afghanistan. 10. Bryophyta, Lycophyta, Sphenophyta, Pterophyta-Eusporangiate and Protoleptosporangiate. *Palaeontographica B*, 243: 103-192.
- Schweitzer, H.J., U., Kirchner, M., van Konijnenburg-van Cittert, J.H.A., 2000. The Rhaeto-Jurassic flora of Iran and Afghanistan. 12. Cycadophyta II. Nilssoniales. *Palaeontographica B*, 279 (1-6): 1-108.
- Schweitzer, H.J., U., Schweitzer, M., Kirchner, J.H.A., van Konijnenburg-van Cittert, J., van Der Burgh, and R. A., Ashraf, 2009. The Rhaeto-Jurassic flora of Iran and Afghanistan. 14. Pterophyta, Leptosporangiateae. *Palaeontographica B*, 279 (1-6): 1-108.
- Seward, A.C., 1894. The Wealden Flora, Part I- Thallopiphyta- Pteridophyta. Catalogue of the Mesozoic plants in the Department of Geology, British Museum. 179 pp. London.
- Seward, A.C., 1898. Fossil plants for students of Botany and Geology. Cambridge Press, X. xviii+ 452 pp.
- Seward, A.C., 1900. The Yorkshire Coast, in: The Jurassic flora. I. 341 p. London.
- Seward, A.C., 1912. Mesozoic plants from Afghanistan and Afghan-Turkistan. *Memoirs of the Geological survey of India, Palaeontologia Indica, new series* 4 (4): 1-57.
- Sitholey, R.V., 1940. Jurassic plants from Afghan-Turkistan. *Palaeontology Indica, n.s.*, 29 (1): 1-25.
- Stanislavski, F.A., 1957. Jurassic Flora of the Don Basin and Dnieper-Donetz region. The Academy of Sciences of Ukraine, Kiev, 1-128.
- Staub, M., 1882. *Ctenopteris cycadea* Bronginart in der fossilen flora Ungars. *Földtani Közlekedési Múzeum, Budapest*, 12: 249-256.
- Sze, H.C., 1933. Mesozoic plants from Kansu. *Memoir of National Research, Institute of Geology*, 13: 65-76.
- Sze, H.C., 1949. Die mesozoischen Flora aus der Hsiangchi Kohlen Serie in West Hupeh. *Palaeontologia Sinica, (n.s., A)* 2: 1-71.
- Sze, H.C., 1952. Pflanzenreste aus dem Jura der Inneren Mongolei. *Science Record*, 5: 183-190.
- Thomas, H.H., 1911. The Jurassic flora of Kamenka in the District of Isium. *Mémoire du Comité Géologique, nouvelles série*, 71: 1-95.
- Thomas, H.H., 1912. *Stachypteris Hallei*: a new Jurassic Fern. *Proceedings of the Cambridge Philosophical Society*, 16: 610-614.
- Vaez-Javadi, F., 2008. Plant macrofossils of Iran: Department of Environment press, Tehran, 236 pp. (In Persian)
- Vaez-Javadi, F., 2011. Middle Jurassic flora from the Dansirit Formation of the Shemshak Group, Alborz, north Iran. *Alcheringa*, 35 (1): 77-102.
- Vaez-Javadi, F., 2012. Plant Macrofossils from Tiar Area, South Amol, Dating and Correlation with the other Florizones of Iran. *Geosciences*, 21 (83): 229-237. (In Persian)
- Vaez-Javadi, F., 2014. Triassic and Jurassic floras and climate of central-east Iran. Geological Survey of Iran, Rahi Pub., 254 pp.
- Vaez-Javadi, F., M., Ghavidel-Syooki, 2002. Plant megafossil remains from Shemshak Formation of Jajarm area, NE Alborz, Iran. *The Palaeobotanist*, 51: 57-72.
- Vaez-Javadi, F., Pour-Latifi, A., 2002. Geology and age of the Mashad phyllites in Dizbad area in the Binalud Mountain. *Geosciences*, 43/44: 80-86.
- Vaez-Javadi, F., A., Pour-Latifi, 2004. Study of Golmakan's plant macrofossils, North-East of Iran. *Geosciences*, 51/52: 98-107. (In Persian)
- Vaez-Javadi, F., M., MirzaeiAtaabadi, 2006. Jurassic plant macrofossils from the Hojedk Formation, Kerman area, east-central Iran. *Alcheringa*, 30: 63-96.
- Vaez-Javadi, F., Abbasi, N., 2012. Plant macrofossils from the Baladeh area (Central Alborz), dating and biostratigraphy, 48 (3): 37-64. (In Persian)
- Van Konijnenburg-van Cittert, J.H.A., 2008. The Jurassic fossil plant record of the UK area. *Proceedings of the Geologists' Association*, 119: 59-72.
- Vozenin-Serra, C., Franceschi, de D., 1999. Flore du Trias supérieur du Viêt Nam (bassins houillers du Quang-Nam et de

- Hongay. *Palaeontographica B*, 249 (1-6): 1-62.
- Walkom, A.B., 1921. Mesozoic Floras of New South Wales. Part 1- Fossil plants from Cockabutta Mountain and Talbragar. *Memoirs of the Geological Survey of New South Wales, Palaeontology*, 12.
- White, M.E., 1981. Revision of the Talbragar Fish Bed Flora (Jurassic) of New South Wales. *Records of the Australian Museum*, 33 (15): 695-721.
- Wilmsen, M., Fürsich, F. T., Taheri, J., 2009. The Shemshak Group (Lower-Middle Jurassic) of the Binalud Mountains, NE Iran: stratigraphy, depositional environments and geodynamic implications. *Geological Society of London, Special Publications*, 312: 175-188.
- Wu, S.Q., Ye, M.N. & Li, B.X., 1980. Upper Triassic and Lower and Middle Jurassic plants from the Hsiangchi Group, western Hubei. *Memoirs of Nanjing Institute of Geology and Paleontology, Academia Sinica*, 14: 63-131. (In Chinese)
- Yokoyama, M., 1890. Jurassic plants from Kaga, Hida and Echizen. *Journal of College of Science Imperial University of Tokyo*, 3 (1): 1-66, pls. 1-14.
- Yokoyama, M., 1906. Mesozoic Plants from China. *Journal of Coll. Science, Imperial University of Japan*, 21 (9): 1-39.
- Zigno, A. d., 1856-1885. *Flora Fossilis Formationis Oolithicae. Le Piante Fossili dell'Oolite*. 2 vols. Padova, vol. 1, livr. 1: 1-32, pls. 1-6 (1856); livr. 2: 33-64, pls. 7-12 (1858); livr. 3-5: 65-223, pls. 13-25 (1867); vol. 2, livr. 1: 1-48, pls. 26-29 (1873); livr. 2, 3: 49-120, pls. 30-37 (1881); livr. 4, 5: 121-203, pls. 38-42 (1885).