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# Oxfordian Ammonites from Hungary

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**Abstract** A general account of the Oxfordian sediments and ammonites from Hungary is given for the first time. Five ammonite associations are studied from the Gerecse and Pilis Mountains (Bakony Unit) and one from the Mecsek Mountains, in southern Hungary. They indicate a late Middle to early Upper Oxfordian age (Bifurcatus to lower Bimammatum Zone.) The age of lower ammonite associations from the Bakony Unit ranges from late Transversarium to lower Bifurcatus Zone on the basis of *Passendorferia* aff. *birmensdorfensis* (Moesch) and *Gregoryceras fouquei* (Kilian). An upper assemblage yielding among other forms, *Euaspidoceras hypselum* (Oppel), *Benetticeras sp.* and *Passendorferia rozaki* Meléndez, is assigned to lower Hypselum Subzone, Bimammatum Zone. The ammonite association from the Mecsek Mountains contains common Aspidoceratids, including *Euaspidoceras hypselum* (Oppel) and Ataxioceratids including some representatives of *Orthos-phinctes* (M & m) close to the *O. tiziani* (Oppel) group, suggesting an upper horizon within the Hypselum Subzone.

## INTRODUCTION

In Hungary, ammonite bearing Jurassic rocks crop out in the territory of the Transdanubian Central Range (Bakony Unit) and in south, in the Mecsek and Villány Mountains [1]. A detailed account, with full references on the Hungarian Jurassic was given lately [2].

Since the early times of the Hungarian geology, a special attention was dedicated to the Jurassic biostratigraphy and ammonitology. Early studies were focussed mainly on the Liassic and Middle Jurassic rocks and fossils. However, detailed references to the Upper Jurassic, mainly Tithonian are far more recent, ranging roughly through the last ten years. Studies on the Hungarian Oxfordian have lagged behind due to the sparse distribution of the outcrops and to the incompleteness of the series. Oxfordian ammonites have been reported previously from the Transdanubian Central Range and the Mecsek Mountains region.

The purpose of this paper is to report the so far unpublished Oxfordian ammonites from Hungary, housed in the Hungarian Natural History Museum, Budapest. The studied material comes partly from the old collections carried out by the Geological Survey. It was completed in the recent years with new collections by the authors.

## OXFORDIAN FACIES AND ROCKS

### Transdanubian Central Range

In the Bakony Unit (which includes the Bakony, Gerecse, Vértes, Pilis Mountains and the block of Tata) there is a chert unit, called Lókút Radiolarite Formation above the Middle Jurassic ammonitico rosso type limestone [3]. A general Bathonian to Callovian age has traditionally been assumed for the radiolarite but, in many places it may represent the Oxfordian and the part of the Kimmeridgian as well. The most important Oxfordian outcrops are shown in Fig. 1.

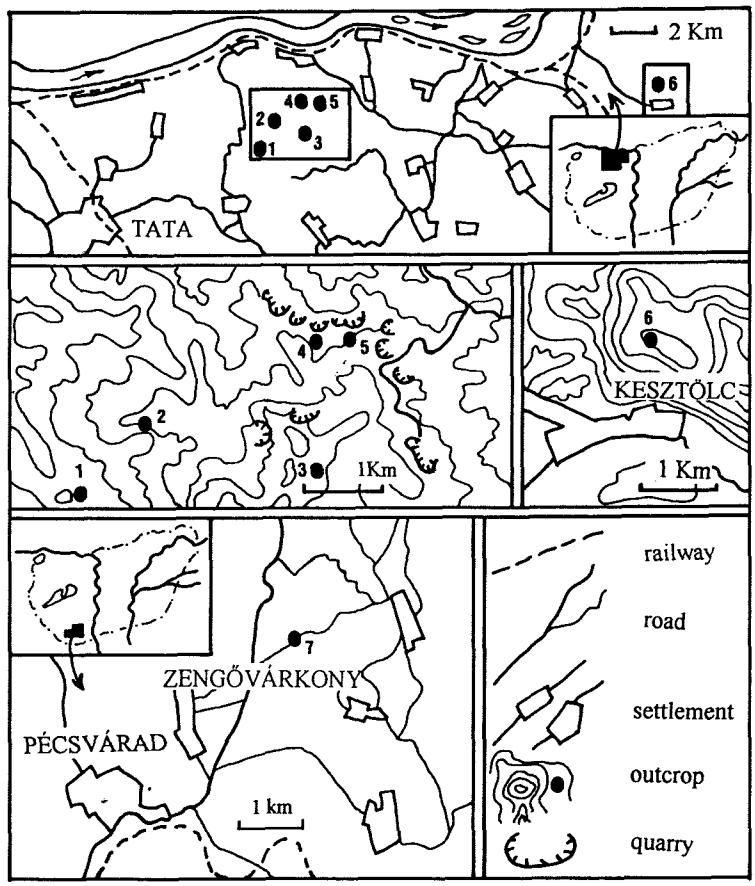


Fig. 1.: Sketch map showing location of the studied profiles. 1: Paprét, 2: Margit Hill, 3: Domoszló, 4: Tölgyhát, 5: Dogger Quarry, 6: Velka Skala, 7: Zengővárkony

The lower boundary of the radiolarite is a diachronous surface, [4,5]. The first ammonite bearing beds above the cherty formation ranges from Middle Oxfordian up to the Kimmeridgian [6]. The age of the upper boundary of the radiolarite has been the matter of discussion for a long time. New data, however, have come from the Oxfordian ammonite biostratigraphy, as discussed below.

The largest continuous Jurassic belt can be found in the Bakony Mts, but so far, no Oxfordian ammonites were found here. The only exception is the Lókút Hill, where a quite complete Upper Jurassic succession has been documented [7]. Above the mid-Jurassic radiolarite, the red nodular limestone yielded poorly preserved big fragments of Euaspidoceras, probably representing the Oxfordian. Above it, there is about 2 meters of Kimmeridgian, and a complete Tithonian and Lower Cretaceous succession.

Farther Northeast, in the Vértes Mountains the Jurassic appears underdeveloped. A Bositra-rich Callovian - Oxfordian cherty formation is recorded [8] but no megafossils were found.

The so called Tata horst is a separated tectonic block of the Central Range, with a Jurassic succession on the top. A rich Upper Jurassic ammonite assemblage of mainly Kimmeridgian and Tithonian cephalopods was reported from here [9]. *Peltoceras transversarium* (Quenstedt) and *Aspidoceras oegir* (Oppel), characteristic elements for the Oxfordian were mentioned.

Later *Holcophylloceras empedoclis* (Gemmellaro), *Taramelliceras* cfr. *costatum* (Quenstedt), *T.* cfr. *kobyi* (Choffat), *Perisphinctes bocconii* (Gemmellaro), *Gregoryceras transversarium* (Quenstedt), *G.* aff. *toucasi* (d'Orbigny), *Euaspidoceras oegir*, (Oppel), *E.* cfr. *ovale* (Neumayr), *E. tietzei* (Neumayr), *Aspidoceras choffati* (Loriol), *Physodoceras altenense* (d'Orbigny) were reported as Oxfordian ammonites [10].

In Tata, the thickness of the extremely condensed and lacunose Upper Jurassic series ranges from 35 to 350 cm [11]. Oxfordian ammonites were found in a very characteristic greyish-white brecciated limestone layer. It is situated between the ?Callovian brown chert, and the red, argillaceous Kimmeridgian limestone. The breccia appears well exposed and very well studied on the surface: it is a thin and constant interval, slightly thickening to the south, where is less brecciated. Altogether 18 specimens, including the species described by Szabó [10] and *Perisphinctes sp.* ex. gr. *subrota* (Choffat), *Gregoryceras sp.* ex. gr. *fouquei* (Kilian), *Euaspidoceras helymense* (?) (Gemmellaro), *"Aspidoceras" insulanum* Gemmellaro were listed. Two specimens of *Gregoryceras* were illustrated also. As a biostratigraphic conclusion, the Transversarium and Bimammatum Zones were reported. The origin of the Oxfordian limestone breccia bank was related to the uplift of the basement at the beginning of the Late Jurassic and to the submarine debris flow onto the uneven sea-bottom.

In the Gerecse Mountains the Jurassic was investigated by the pioneer Hofmann already [12]. Much was done by Gyula and Gusztáv Vigh, father and son, geologist, who have published many geological, paleontological descriptions, excursion-guides, maps, and map-explanations on the Jurassic of the Gerecse Mountains [13,14]. According to the data, Oxfordian ammonites were found only in the red to white, c. 60 cm thick brecciated limestone bed, similar to that described above, from Tata. This bed is intercalated into the radiolarite (e.g. Margit Hill section), or situated just above it (Tölgyhát). According to Vigh, some 10 cm of siliceous limestone below the brecciated level may appear in certain places, belonging to the Lower Oxfordian as well.

The thin Oxfordian bank is cropping out in small patches in the vicinity of the Margit, Nagy-Pisznice, Kis-Gerecse hills. Oxfordian bearing profiles were illustrated by G. Vigh and J. Konda [14,15,16]. From the so called Domoszló-tető, the following forms were mentioned: *Phylloceras plicatum*, Neumayr, *Calliphylloceras sp.* ex. gr. *C. manfredi* (Oppel), *Holcophylloceras mediterraneum* (Neumayr), *Sowerbyceras sp.*, *Gregoryceras toucasi* (d'Orbigny), and *Arisphinctes sp.* div.

Later collecting revealed a richer fauna, briefly reviewed by Főzy [16].

The Velka Skala section in the Pilis Mountains represents the easternmost outcrop of the Upper Jurassic in the Transdanubian Central Range. The locality was discovered by Schafarzik [17], and Kimmeridgian and Tithonian ammonites were reported by Gy. Vigh [18]. Genera known from the Gerecse Mountains and the unique occurrence of *Paraspidoceras* and *Benetticeras* was also mentioned from this outcrop [16].

**Mecsek Mountains**

Oxfordian ammonites were collected in the Mecsek Mountains, in one locality, at Zengővárkony only. Here, a 1 m thick, compact, white to yellow, moderately nodular limestone bank yielded the fossils.

Although the Oxfordian and Kimmeridgian rocks were recognised by the pioneer Peters [19], and the Tithonian was described by Böckh already [20], the Upper Jurassic is still very poorly known. Oxfordian ammonites (only *Holcophylloceras* cf. *polyolcum* Benecke and *Sowerbyceras tortisulcatum* d'Orbigny) were listed from Ófalu, Óbánya and Pécsvárad [21], but no specimens from the Upper Jurassic ammonites of the Mecsek Mountains were illustrated. The first preliminary evaluation of the newly collected ammonites was given recently [22].

## AMMONITE ASSOCIATIONS

### Transdanubian Central Range

In the Gerecse Mountains, Oxfordian ammonites were collected from the different localities of Domoszló, Margit Hill, Tölgyhát, Paprét and Dogger Quarry. Detailes on the Upper Jurassic biostratigraphy of these profiles were recently summarised [16].

Ammonite assemblages are discussed within the biostratigraphical scheme published by Meléndez & Fontana [23].

In the outcrop of Dogger Quarry, a single fragmentary specimen of *Passendorferia* was found. It is close to the form figured as *Passendorferia* n. sp. aff. *birmensdorfensis* (Moesch) [24] and to *Passendorferia tenuis* Meléndez (1989, pl. 1, fig.1, non Enay, 1966) [25,26]. It may represent a somewhat high horizon within the Schilli Subzone or perhaps the lower part of the Rotoides Subzone of the Transversarium Zone.

In the outcrop of Margit Hill the single Oxfordian limestone bank intercalated into the upper part of the radiolarite has yielded some Middle Oxfordian ammonites including *Sequeirosia (*M *Sequeirosia) sp.* aff. *brochwiczi* Sequeiros, *Sequeirosia sp.* (Plate, Fig. 4) and two well-preserved specimens of *Gregoryceras* cf. *fouquei* (Kilian) showing some transitional features to *G. riazi* (Grossouvre) in the inner whorls such as flexuous, biplicate retroverse ribbing. This assemblage may represent a late Transversarium to early Bifurcatus Zone horizon. Tithonian nodular limestone overlie directly the radiolarite unit, thus the Kimmeridgian is not documented.

The ammonite assemblage from the Domoszló outcrop comes entirely from older collections. It is mostly formed by specimens of *Gregoryceras* and *Passendorferia*. Representatives of the genus *Gregoryceras* show close affinities with *G. fouquei* (Kilian) (Plate, Figs. 2,3) in the outer whorl and flexuous, somewhat retroverse biplicate ribbing on the inner whorls resembling *G. riazi* (Grossouvre). They probably represent a lower horizon within the Bifurcatus Zone, Stenocycloides Subzone. Two specimens show closer affinities with Kilian's type specimen, with rectiradiate, stouter, single, tuberculate ribs. They might represent a higher horizon within this zone. Representatives of *Passendorferia* (Plate, Figs. 1,5) belong mostly to the *torcalense* (Kilian) group (M & m), from the lower Bifurcatus Zone, characterized by the fine and dense ribbing, with massive rounded to early compressed whorl section [27,28]. Some specimens, however, show extremely evolute coiling with thick, sharp ribbing and quadratic whorl section. They are closest to *P. teresiformis* (Brochwicz-Lewinski), from the upper Stenocycloides to Grossouvrei Subzone. The Domoszló assemblage, therefore, seems to represent a probably condensed association of two different horizons of the Bifurcatus Zone.

A similar Middle Oxfordian ammonite association comes from the section of Paprét. It includes a well-preserved specimen of *Gregoryceras fouquei* (Kilian) still showing a short "*riazi* stage" in the inner whorls, and some fragmentary specimens of *Passendorferia (*M *Passendorferia)* gr. *torcalense* (Kilian) somewhat transitional to *P. teresiformis* (Brochwicz-Lewinski) and *Sequeirosia* (M & m) *sp.* This association might represent a somewhat high horizon in the Stenocycloides Subzone, or the base of Grossouvrei Subzone.

Above the Oxfordian beds, a very condensed Kimmeridgian and mainly Tithonian succession can be found, strongly reduced in thickness (less than 1 m).

In the locality of Tölgyhát the Jurassic series crops out in an abandoned quarry. The Middle Oxfordian 30 to 40 cm thick limestone bank overlies directly the radiolarite and it is followed by Tithonian sediments, evidencing a probable gap of the Kimmeridgian. The ammonite association includes, besides numerous Phylloceratina and big-sized *Euaspidoceras* one very typical specimen of *Gregoryceras fouquei* (Kilian), characterized by the involute coiling with rectiradiate ribbing and single ribs generally looped and tuberculate in the umbilical margin [29]. *Sequeirosia (*M *Sequeirosia) sp., Passendorferia (*M *Passendorferia) teresiformis* (Brochwicz-Lewinski), *Passendorferia uptonioides* (Enay) also occur. Some specimens close to this species show a somewhat involute coiling and trifurcate or intercalary ribs, appearing as intermediate to early

*Orthosphinctes*. This ammonite association probably represents a somewhat high horizon within Bifurcatus Zone, in the Grossouvrei Subzone [26,30].

The Kimmeridgian is very poorly documented in Tölgyhát, while the overlying Tithonian is more complate.

Oxfordian ammonite association from Velka Skala, in the Pilis Mountains, at the eastern part of the Bakony Unit, show some consistent differences with those from the Gerecse Mountains. Again, besides the common Phylloceratina, it is specially noteworthy the record of *Orthosphinctes* (M & m) *sp.* aff. *tiziani* (Oppel), showing intermediate features between *O. fontannessi* (Choffat) and the Oppel's species, and most of all, some common representatives of *Passendorferia* (M & m) *rozaki* Meléndez. A single specimen show some transitional features to *P. (*m *Enayites) gygii* (Brochwicz-Lewinski & Rozak). No representatives of *Gregoryceras* has so far been reported from this locality. Aspidoceratids are common, especially specimens of *Euaspidoceras* gr. *hypselum* (Oppel). *Paraspidoceras sp.*, and the extremely inflated *Benetticeras sp.* were reported for the first time from the profile.

The assemblage is comparable to those described from the Polish Jura Chain [31] and from the Iberian Chain, Spain [25] from the lower part of Hypselum Subzone, Bimammatum Zone (lower Upper Oxfordian). So the Pilis Mountains assemblage probably represents a lowermost horizon within the Bimammatum Zone.

The Velka Skala section is a strongly tectonised one, so the succession of the under and overlying beds is difficult to understand.

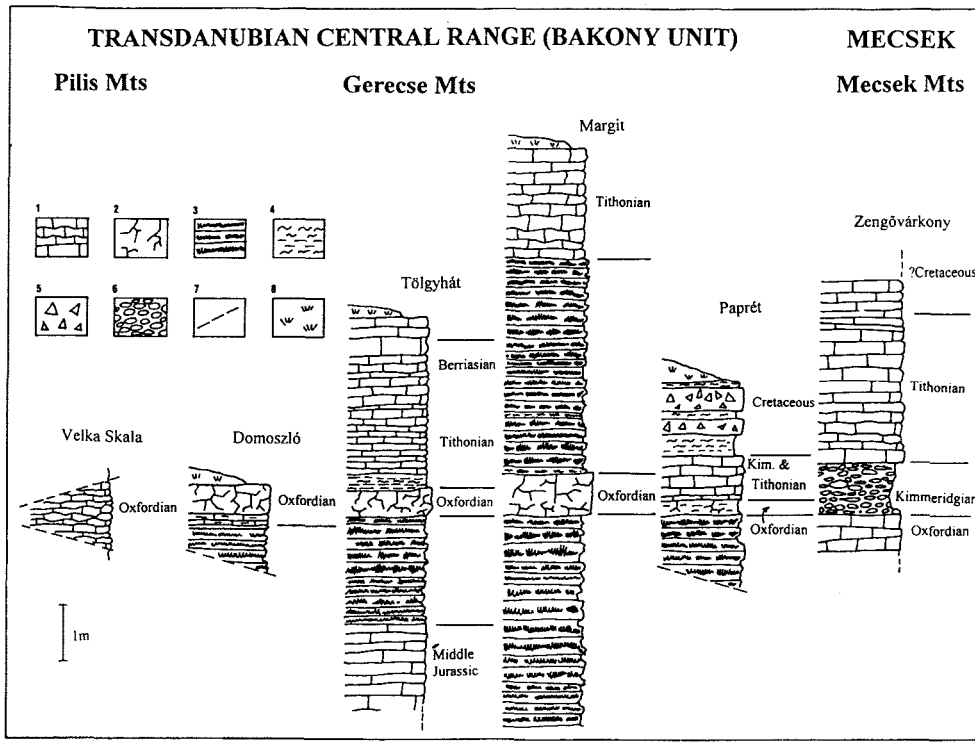


Fig. 2.: Simplified logs of the studied profiles. 1: Nodular or platty limestone, 2: Oxfordian, brecciated siliceous limestone, 3: Radiolarite, 4: Marly intercalations, 5: Polimict, brecciated limestone, 6: Strongly nodular marly limestone, 7: tectonic contact, 8: debries, soil.

**Mecsek Mountains**

In the Mecsek Mountains, in southern Hungary, Oxfordian ammonites have been collected at the section of Zengővárkony, near Pécs (Fig.1.) The ammonite assemblage includes specimens of *Euaspidoceras* cf. *hypselum* (Oppel) and common *Orthosphinctes* close to the *tiziani* (Oppel) group. Components of this assemblage show a wide, continuous morphological variability, from involute, compressed densicostate forms (*Subdiscosphinctes* morphology) to evolute crassicostate serpenticones, closer to the type of this species. This assemblage may represent a somewhat high horizon within the Hypselum Subzone, Bimammatum Zone, whilst the typical *tiziani* assemblage comes from the Bimammatum Subzone. The studied associations shows much closer affinities with Southwest Europe Submediterranean than with the true Mediterranean Province, although, so far, no representatives of Passendorferinae or Epipeltoceratinae were found.

The Oxfordian bank at Zengővárkony is covered by Kimmeridgian nodular limestone beds and a much thicker Tithonian - Lower Cretaceous succession.

## CONCLUSIONS

In the Transdanubian Central Range (in the Gerecse and Pilis Mountains) the Oxfordian ammonite-bearing limestone bank is intercalated into the "mid-Jurassic" radiolarite, or situated above it (Fig. 2.) The age of this brecciated limestone bank is probably slightly diachronous, ranging from the upper Transversarium Zone (Schilli to Rotoides Subzone) to the middle-upper Bifurcatus Zone (Grossouvrei Subzone) and even lower Hypselum Subzone at Pilis Mountains. The typical Mediterranean character of the ammonite associations is underlined, besides the high share of Phylloceratina, by the representatives of *Gregoryceras* and *Passendorferia*. The wealth of these forms in this area has allowed a precise correlation with West Europe submediterranean areas and the paleontological characterization of some still poorly known species of both *Passendorferia* and *Gregoryceras*. Oxfordian ammonite associations from the Mecsek Mountains, characterized by the wealth of Ataxioceratinae, represent a slightly younger horizon in the Bimammatum Zone and show a typical submediterranean character (northern slope of the Tethys). This evidences a good paleogeographic connection of this area with the south European platform during the upper Oxfordian.

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Fig. 1. *Passendorferia (?) torcalense* (Kilian), M 94 58, probably a nucleus of a fragmentary macroconch, Domoszló, Gerecse Mountains

Fig. 2. *Gregoryceras* aff. *fouquei* (Kilian), M 94 42, a transitional form between *G. riazi* (Gross.) and *G. fouquei* (Kilian), adult, nearly complate macroconch, Domoszló, Gerecse Mountains

Fig. 3. *Gregoryceras fouquei* (Kilian), M 94 65, slightly incomplate (?) microconch, Domoszló, Gerecse

Fig. 4. *Sequeirosia sp.*, M 94 20, wholy septate fragmant of a macroconch, Margit Hill, Gerecse Mountain

Fig. 5. *Passendorferia torcalense* (Kilian), M 94 55, young, incomplate macroconch, Domoszló, Gerecse Mountains


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