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The Pelsonian Substage on the Balaton Highland (Middle Triassic, Hungary)

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INTRODUCTION

ATTILA VÖRÖS

The Balaton Highland is one of the most renowned and important reference areas of the Alpine–Tethyan Triassic stratigraphy (see TOZER 1984). Especially the Middle Triassic strata of this region became famous very early, in the 1870's, due to the magnificent pioneering works by BÖCKH (1872, 1873) and MOJSISOVICS (1873, 1882). One of the stratigraphical highlights was the "*Trachyceras Reitzi* horizon" whose importance is still acknowledged in the recent discussions on selecting the GSSP of the Anisian/Ladinian boundary. Another formation proving to be of outstanding importance was the "Muschelkalk" with "*Ammonites Balatonicus*". This ammonoid species, lending its name to one of the earliest described Middle Triassic genera (*Balatonites* MOJSISOVICS, 1879), is still the best marker of the substage now called Pelsonian (the middle Substage of the Anisian Stage). The first official naming of this substage as "Balatonisch" performed by MOJSISOVICS, WAAGEN & DIENER (1895) was a kind of tribute to the Balaton Highland.

The next effort to contribute to the knowledge of the Pelsonian of the Balaton Highland is connected to the ambitious international project entitled "Wissenschaftliche Erforschung des Balatonsees" (Scientific Research of the Lake Balaton) lead by L. Lóczy sen. at the turn of the twentieth century. The product was a series of monographs which incorporated some very important stratigraphical (LACZKÓ 1911) and palaeontological (*e.g.* DIENER 1899 and ARTHABER 1903) contributions and was complemented with a comprehensive closing volume (LÓCZY 1913, 1916).

In the next decades, regrettably little progress was achieved in the research of the Middle Triassic of the Balaton Highland. Perhaps by this reason, PIA (1930, figs 2, 3), when introducing the substage name "Pelson", clearly referring to the Roman name of the Lake Balaton (*Lacus Pelso*), indicated the Dont valley as type section.

In the 1960–1970's, Imre Szabó made extensive field work and stratigraphical research at the Balaton Highland, but only a minor part of this voluminous knowledge was published (SZABÓ 1972, SZABÓ *et al.* 1980). The pressing interest by the international scientific community (*e.g.* ASSERETO 1969, 1971; Workshop Meeting on IGCP Project 4., 1978) clearly indicated the necessity of new studies and an updated synthesis regarding the Triassic stratigraphy of the Balaton Highland. The review papers by DETRE (1974, 1975) underscored some of the problems but did not fill the gap of knowledge.

In the last two decades, important excavations and boreholes have been established at the Balaton Highland in the scope of the state-financed Geological Key Section Programme, coordinated by J. Fülöp and J. Haas. On this ground — partly connected to the detailed geological mapping project by the Geological Institute of Hungary (MÁFI — led by Géza Császár and Tamás Budai), partly sponsored by the National Scientific Research Fund (OTKA) — we have made detailed collections in many important stratigraphical sections and greatly improved the Middle Triassic stratigraphy of the Balaton Highland. The results have been integrated to the comprehensive volume on the geological mapping (BUDAI *et al.* 1999a) and to handbooks (*e.g.* HAAS *et al.* 2001). Part of these results contributed to the recent resurgence in the "Anisian/Ladinian boundary problem" (VÖRÖS 1993, VÖRÖS *et al.* 1996, 2003). The other part of the new results was mainly connected to the Pelsonian strata; some of them were published in preliminary contributions (VÖRÖS 1987, TATZREITER & VÖRÖS 1991).

In the last years, a special grant by the National Scientific Research Fund (OTKA, T 26278) was dedicated to the updated synthesis of stratigraphy and a redefinition of the Pelsonian Substage at the Balaton Highland. In the course of our work we have made new, detailed, bed-by-bed collections of fossils and samples. The new data were integrated with the available, previous knowledge into a coherent data base. The main purposes were the biostratigraphical subdivision and definition of the Substage with designation of its boundaries and the description of its lithological and palaeontological content.

The present volume is intended to sum up the recent knowledge on the Pelsonian Substage at the Balaton Highland.

The first chapter, written by T. Budai and A. Vörös is a concise introduction to the geological setting of the Balaton Highland and the general relationships of the Pelsonian formations.

The multi-authored chapter with the heading "Stratigraphy" (edited by A. Vörös) gives a comprehensive description of the results attained in the Pelsonian stratigraphy at the Balaton Highland, with special emphasis on the biostratigraphy of several different fossil groups (ammonoids, conodonts, foraminifers, dasycladaceans). Other aspects of stratigraphy, as magneto-, and sequence stratigraphy are briefly summarised and an attempt to provide an integrated stratigraphy is also given. An informal designation of the stratotype of the Pelsonian Substage at its type region (Balaton Highland) and a short summary of the sedimentary evolution close the first part of the volume.

The second part contains, profusely illustrated chapters which provide the palaeontological documentation of the main fossil groups (except foraminifers which were described monographically previously: ORAVECZ-SCHEFFER 1987) and portray the microfacies of the Pelsonian formations at the Balaton Highland. Ammonoids were systematically described by A. Vörös, the important conodonts were discussed and illustrated by S. Kovács. Systematic descriptions of other fossil groups include brachiopods (J. Pálfy), bivalves (I. Szente & A. Vörös) and dasycladaceans (O. Piros); the carbonate microfacies were described and illustrated by Gy. Lelkes and A. Vörös.

As leader of the project and scientific editor of the present volume, I have to express my sincere thanks to many persons and institutions.

During field-work and collecting fossils, I received indispensable assistance from T. Budai, I. Szabó, J. Pálfy and I. Szente. Similar, occasional help was given by other colleagues, *e.g.* G. Csillag and A. Galácz. Here I want to mention with special emphasis and deep sorrow the name of the late L. Dosztály who was the most enthusiastic and talented collector among us and whose unexpected death in 1999 is still unbelievable for us.

Thanks are due to J. Haas for continuous scientific support and the painstaking work done as the referee of this manuscript and to I. Kapolcsi Szabó-Stark, for technical assistance.

The facilities provided by the Hungarian Natural History Museum and the Research Group for Palaeontology of the Hungarian Academy of Sciences are acknowledged.

The publication of this volume was substantially sponsored by the grant No. T26278 of the National Research Fund (OTKA) and was further helped by the grants No. T29654, T43325 and T43341. Essential financial and technical support was given by the Geological Institute of Hungary whose kind permission for publishing this monograph as a volume of the magnificent series of Geologica Hungarica is especially greatly appreciated. Personal thanks are due to K. Brezsnyánszky (director of the Geological Institute of Hungary) and to O. Piros and D. Simonyi for the careful technical editing and computer graphic work.

Budapest, 2003. december 1.

Attila Vörös

Part I

Geology and stratigraphy

GEOLOGICAL SETTING

Tamás Budai & Attila Vörös

The Balaton Highland belongs to the Bakony Mountains, located in the southwestern part of the Transdanubian Range (TR) in Hungary. The structure of the TR is dominated by a NE–SW trending syncline. The Balaton Highland that makes up the southern flank of the syncline exposes the oldest rocks of the TR. The structure of the Balaton Highland was basically determined by compressional movements normal to the axis of the syncline. The most dominant structural element of the Balaton Highland is the Litér thrust of SW–NE strike, that resulted in a repetition of the Permian–Triassic sequence. The Pelsonian formations can be traced as more or less parallel belts on both sides of the Litér thrust (Figure G-1). Strike of the southern belt is disrupted by transverse thrusts ("Dörgicse horse-tail structure") in the middle part of the Balaton Highland and by folded structures in several parts of the northern belt (Budai *et al.* 1999a, b). These dislocations are manifested in the anomalously wide surface extension of the Pelsonian formations.

The middle part of the Anisian of the Balaton Highland can be subdivided into the following three formations: Megyehegy Dolomite, Tagyon Limestone and Felsőörs Limestone Formation (lower part). The latter two represent the Pelsonian Substage whereas the Megyehegy Dolomite is placed into the Bithynian Substage according to the new concept presented in this volume (Figure G-2). Nevertheless, because this formation plays an essential role in the geological framework, and also because it was previously regarded as Pelsonian, the main features of the Megyehegy Dolomite will also be shortly described below. The coeval Pelsonian formations are characterised by significant lateral thickness changes (Figure G-3).

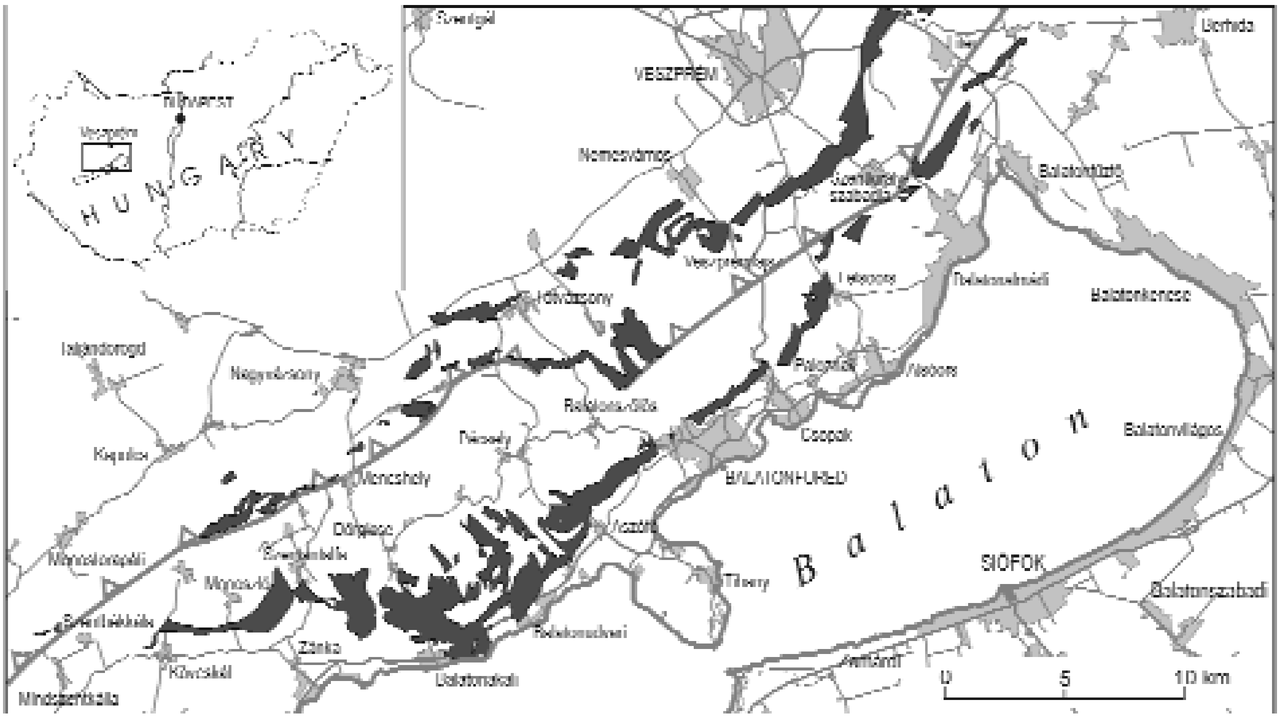

Figure G-1. Surface distribution of the Pelsonian formations (dark shaded) along the Balaton Highland with the indication of the Litér thrust (barbed line)

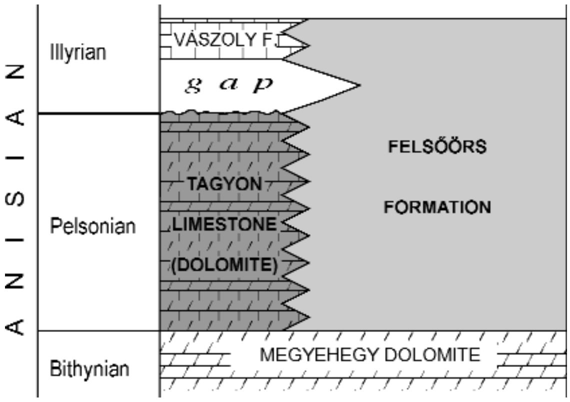

Figure G-2. Chronostratigraphic chart of the Pelsonian formations of the Balaton Highland

The **Megyehegy Dolomite Formation** consists of light grey, bedded dolomite. The lower part of the formation is made up by argillaceous, slightly bituminous, often biodetrital dolomite containing crinoidal skeletal fragments and dasycladaceans (*Physoporella pauciforata, Ph. pauciforata undulata, Oligoporella* sp.). The original sedimentary sructures have been commonly destroyed and dolosparitic texture became prevailing. The transitional interval towards the overlying Felsőörs Limestone is made up by argillaceous, bituminous dolomite.

The thickness of the Megyehegy Formation is not more than 10–20 metres in the northern belt and in the western part of the southern belt. In the central part of the Balaton Highland and on the Veszprém Plateau its thickness may reach 250 m.

The Megyehegy Dolomite represents a shallow subtidal carbonate ramp facies.

The platform carbonate succession of the **Tagyon Formation** is made up by cyclic alternation of white, light grey or beige bedded limestone and yellowish laminitic carbonates. The shallow subtidal fossiliferous limestone beds (akin to the C member of the Lofer cycle) contain rich dasycladacean (see PIROS, this volume) and foraminifer assemblages (ORAVECZNÉ SCHEFFER 1980, ORAVECZ-SCHEFFER 1987). The thin stratified, calcite-spotted limestone beds of intertidal facies corresponds to B member of the Lofer cycle. In some horizons, supratidal lithofacies were also detected (BUDAI *et al.* 1993). The Tagyon Formation develops gradually from the underlying Megyehegy Dolomite, while its upper boundary to the overlying Upper Illyrian crinoidal, ammonitic limestone (Vászoly Formation) is sharp (BUDAI & VÖRÖS 1992; BUDAI & HAAS 1997, VÖRÖS *et al.* 1997).

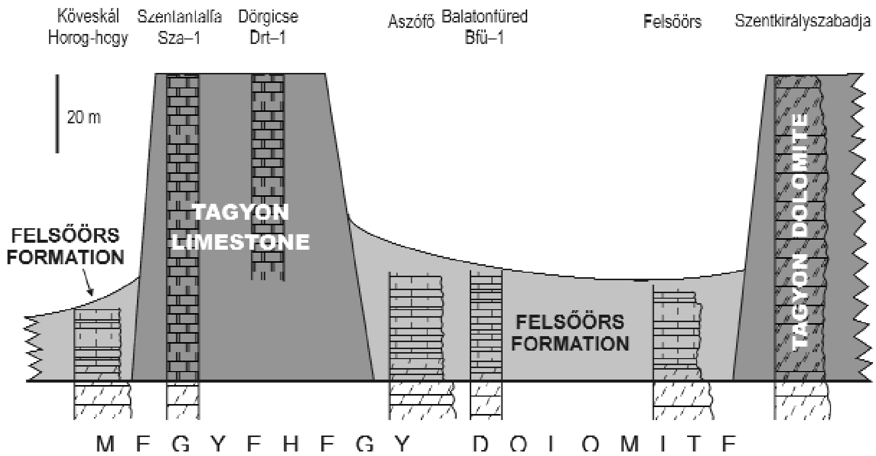

Figure G-3. Stratigraphic relationship of the Pelsonian formations along the strike of the Balaton Highland, lateral changes in facies and thickness

The areal extent of the typical (non-dolomitised) Tagyon Limestone is restricted to the middle part of the Balaton Highland where its thickness varies between 50–100 m. On the Veszprém Plateau, the formation is represented by a cyclic dolomite sequence that shows the characteristic sedimentological features of the Tagyon Limestone; it is informally called „Tagyon Dolomite". The upper part of the platform carbonate is penetrated by neptunian dykes filled with red crinoidal dolomitised limestone (BUDAI *et al.* 1993, 2001). The truncated surface of the platform carbonate is covered by a few centimetres of red clay of palaeosol origin, that is overlain by dolomitised limestone with ammonoids of late Illyrian age (VÖRÖS *et al.* 1997, BUDAI & HAAS 1997).

Concerning its facies characteristics and palaeogeographic position, the Tagyon Limestone is similar to the Steinalm Limestone and the Dosso dei Morti Limestone in Lombardy (BUDAI 1992, BUDAI *et al.* 1993).

The **Felsőörs Formation** represents a Pelsonian basin succession in the Balaton Highland. The lower part of the formation consists of bituminous, yellowish-grey, clayey dolomite. The thickness of this "transitional unit" above the Megyehegy Dolomite is about 10 m. The lower boundary of the Pelsonian substage can be drawn within the upper part of this unit. The Felsőörs Formation is made up of brownish-grey limestones, argillaceous limestones, and marls with tuffite intercalations in the upper part. It is subdivided into the following three, partly coeval members:

— The Forráshegy Member, that consists of grey, bedded, nodular limestone with dark grey chert nodules and lenses. Upwards the limestone becomes flaser bedded with marl intercalations.

— The Horoghegy Member, that is made up of poorly bedded, in some sections (*e.g.* at Felsőörs) clayey, biodetrital limestone. The rich fossil assemblage consists mostly of crinoids and brachiopods (see PÁLFY 1986 and this volume). In the Aszófő section, the member is characterized by redeposited lithoclasts of platform foreslope origin (BUDAI & HAAS 1997).

— The Bocsár Member is composed of dark grey, even bedded, laminated, bituminous limestone, tuffitic limestone and marl. Ammonites and pseudo-planktonic bivalves are common (Vörös 1987, Vörös *et al.* 1997).

The thickness of the whole formation (including the Illyrian part) shows a characteristic trend along the Balaton Highland. It reaches the greatest value (about 150 m) near the platform to basin boundary at Aszófő. From there it decreases gradually to the NE and pinches out on the Megye-hegy. The thickness and the age of the different members are also variable. The areal extent of the Horoghegy Member is restricted to the surroundings of the Pelsonian platforms. Its thickness in the Felsőörs section is about 4 m, in the Aszófő section is about 3 m (Budai & Vörös 1988; Tatzreiter & Vörös 1991), whereas in its type section at Köveskál (Horog-hegy) it is less than one metre (Vörös & Pálfy 2002). The Bocsár Member is the most characteristic lithofacies in the basin interior between Balatonfüred and Aszófő. In the borehole Balatonfüred–1, the whole formation is represented exclusively by this lithofacies, in a thickness exceeding 80 m. The Forráshegy Member is characteristic to the northeastern part of the southern belt (Felsőörs, Megye-hegy).

Considering only the lower, Pelsonian part of the Felsőörs Formation, the thickness of this interval is remarkably uniform. In four well documented sections, the thickness of the Pelsonian sequence is not less than 20 m and rarelyexceed 30 m (Figure G-2). This implies that the above described asymmetric pattern recorded in the thickness of the entire Felsőörs Formation developed only in the Illyrian.

STRATIGRAPHY

ATTILA VÖRÖS

TAMÁS BUDAI, SÁNDOR KOVÁCS, OLGA PIROS & IMRE SZABÓ

LOCALITIES (ROCKS AND FOSSILS)

(ATTILA VÖRÖS, TAMÁS BUDAI & IMRE SZABÓ)

The Pelsonian strata have been known in many smaller outcrops at the Balaton Highland since the second half of the eighteenth century (ZEPHAROVICH 1856, BÖCKH 1872, 1873, LÓCZY 1913, 1916, *etc.*). In the course of our recent project, we have tried to identifiy and sample these classical localities but we have only partly been successful. In the hills above Balatoncsicsó, we have not found fossiliferous Pelsonian beds. On the Recsek-hegy at Hidegkút and the Som-hegy ("Gyűrtető, "Hegyes-gyűr" in the classical literature) at Nemesvámos, fragments of Pelsonian ammonoids were collected but a closer examination was hindered by the vegetation and soil. The very important classical Pelsonian localities on the hillsides above Balatonfüred were also inaccessible due to the expansion of settlements.

We were more successful at other places. Suitable sections were exposed in artificial trenches at four classical localities (Köveskál, Mencshely, Aszófő, Felsőörs), where detailed, bed-by-bed collection of fossils was also carried out (Figure S-1). A few other surface outcrops provided important lithological or palaeontological data. In the course of the geological mapping programme of the Geological Institute of Hungary several deep boreholes were drilled which penetrated the Pelsonian sequence; part of the data obtained from these cores are used in the present synthesis.

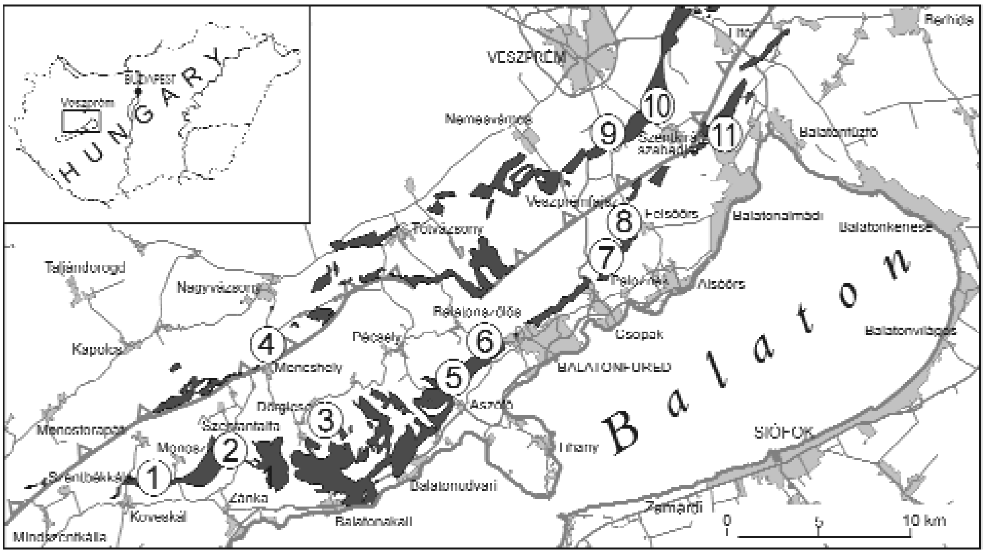

Figure S-1. Locality map of the Pelsonian measured sections, important boreholes and other localities along the Balaton Highland indicating the distribution of the Pelsonian formations (shaded) and the Litér overthrust (barbed line)

1 — Köveskál, Horog-hegy; 2 — Szentantalfa Szaf–1 borehole; 3 — Dörgicse Drt–1 borehole; 4 — Mencshely, Cser-tető; 5 — Aszófő; 6 — Balatonfüred Bfü–1 borehole; 7 — Paloznak Pat–1 borehole; 8 — Felsőörs, Forrás-hegy; 9 — Veszprém, Szabadság-puszta; 10 — Szentkirályszabadja, airport quarry; 11 — Balatonalmádi, Megye-hegy

MEASURED SECTIONS

Köveskál, Horog-hegy

This locality was first mentioned in an early report by ZEPHAROVICH (1856) and the brachiopod species *"Spiriferina" koeveskalyensis* (STUR 1865), and the genus *Koeveskallina* were named after the village Köveskál. These records refer to a small hill called Horog-hegy (or Mezőmál in the earlier literature), two kilometres east of the village, where Middle Triassic limestones were quarried in small pits.

BÖCKH (1872, 1873) described the fundamental geological features of the locality. In the northward dipping sequence, he distinguished a basal, platy limestone overlain by a dolomite forming the hilltop, followed by brachiopod limestone (“Recoaro” limestone) and bituminous, platy limestone, and, finally, the grey “Reifling” limestone. BÖCKH (l. c.) listed a rich brachiopod fauna from the “Recoaro” limestone and observed that “*Ammonites Balatonicus*” (nomen nudum at that time) occurred both in the brachiopod limestone and in the bituminous, platy limestone.

LÓCZY (1913, 1916) drew a sketchy but informative geological profile of the Horog-hegy. Later stratigraphical reviews (*e.g.* BALOGH *et al.* 1983, CROS & SZABÓ 1984) merely summarised the results of the previous authors.

PÁLFY (1986, 1991) made new collections at the locality. He recognised that two different types of “Recoaro” limestone occurred: a reddish-brown and another, grey, bituminous, siliceous, organodetrital limestone, but their stratigraphical relationship remained unclear.

During a short visit in 1995, T. Budai, L. Dosztály, I. Szabó and A. Vörös collected ammonoids from loose blocks in the area, which indicated the presence of both the Middle Anisian Balatonicus Zone and the uppermost Anisian “*Lardaroceras* beds”.

In 2001, J. Pálfy, I. Szente and A. Vörös made a more detailed field survey on the northern slope of the Horog-hegy, excavated a few small artificial exposures and collected fossils (brachiopods, ammonoids, bivalves) at four points (VÖRÖS & PÁLFY 2002).

The section

The Horog-hegy (265 m) lies 2 km ENE of the village of Köveskál. The bulk of the hill is formed by Megyehegy Dolomite, overlain by gently dipping beds of Felsőörs Limestone (Pelsonian to Illyrian), about 40 m in thickness. The fossiliferous localities occur on the forested northern slope of Horog-hegy, between the hilltop and an E–W running forest track. Four small outcrops were excavated and studied.

Horog-hegy I. (Figure S-2) The lowermost exposed unit is a more than 50 cm thick, light grey, slightly siliceous, unfossiliferous limestone (mudstone). This is overlain, with a sharp contact, by a 40 cm thick, light-brown, coarse-grained bioclastic limestone with brachiopods of rock-forming amount (“upper Recoaro”; this rock-type is very widespread on the hillside and provided the brachiopod fauna of the previous collections by PÁLFY (1986). On the irregular top of the brachiopod limestone, a thin (5–10 cm) layer of ochre-yellow, fine-grained crinoidal limestone follows which yielded a moderately rich, poorly preserved ammonoid fauna.

Horog-hegy II. The exposed sequence is almost the same as in Horog-hegy I., but here the lowermost mudstone is well-bedded, slightly bituminous and yielded a poorly preserved *Bulogites*, and the brachiopod limestone (“upper Recoaro”) attains only 20 cm thickness.

Horog-hegy III. Nearer to the hilltop, 40 m southwards from Horog-hegy I, a small pit exposes a few thin beds of monotonous, dark grey, bituminous limestones which provided some ammonoids. The measured dip is 20° to the NNW (320º).

Horog-hegy IV. Another small pit 10 m southwards from the previous one. A thin (10–15 cm) layer of brachiopod-rich, light grey bioclastic limestone (“lower Recoaro”), intercalated between dark grey, bituminous limestone layers is exposed here. About 20 cm below, a yellowish-grey, mottled, pebbly mudstone layer appears. The meas-

Figure S-2. The outcrop Horog-hegy I. The massive bed of “upper Recoaro” (Upper Pelsonian) is in the centre

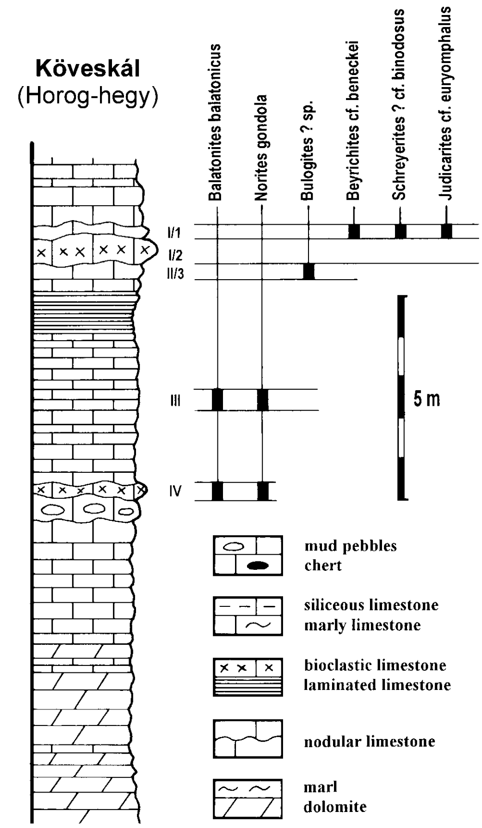

Figure S-3. Composite stratigraphical column and ammonoid range chart of the Pelsonian part of the Köveskál (Horog-hegy) section ured dip is 18° to the NNW (330º). Apart from brachiopods and bivalves, this biodetrital bed also yielded a few ammonoids.

On the basis of the scattered outcrops, a composite lithological column of the Middle to Upper Anisian sequence at the northern slope of Horog-hegy was constructed (Figure S-3). The eight metres thick, measured part of the section (between Horog-hegy I and IV) was complemented by observations on the distribution of loose rock fragments. Altogether, considering an average dip of 15°, the thickness of the Felsőörs Limestone Formation (FLF) seems to exceed 35 m.

Above the Megyehegy Dolomite the sequence starts with a dolomitised "transitional unit", and higher up it contains a level with mud intraclasts embedded in a yellow-mottled matrix, which can be interpreted as a slope derived debris flow. The next, 10 cm-thick brachiopod limestone layer ("lower Recoaro") corresponds to the Horoghegy Member of the FLF and is interpreted as an accumulation of biodetritus redeposited from neighbouring shallow marine areas. The following, 5 m thick, well-bedded, bituminous limestone unit represents the Bocsár Member of the FLF. In its upper one-third, it contains a thin bedded, laminated interval which is also characteristic to the correlative horizons of other basinal sections of FLF (*e.g.* at Aszófő). The unique feature of this section is that the Horoghegy Member appears again, in a higher, separate level, in the form of a few dm thick, brownish brachiopod limestone bed ("upper Recoaro"). The next, ochre-yellow, fine-grained crinoidal limestone layer with many poorly preserved ammonoids has no known counterpart in other Anisian sections of the Balaton Highland. It probably forms a transition to the overlying mudstone layers of the FLF which become more and more siliceous and cherty higher up and commonly contain silicified ammonoid remains ("Forráshegy Member").

Fossils

The localities described above yielded bivalves, ammonoids and extremely large amount of brachiopods. A few gastropods and nautilids were also collected but were not identified more precisely. The determined taxa are listed below, according to localities and systematic order. Their detailed descriptions, including specimen number data are presented in the respective chapters of this volume. Microfossils were not studied.

Horog-hegy I + II.

Ammonoidea (determined by A. Vörös):

Bulogites ? sp.
Beyrichites cf. *beneckei* (Mojsisovics, 1881)
Schreyerites ? cf. *binodosus* (Hauer, 1851)
Ptychites ? sp. indet.
Judicarites cf. *euryomphalus* (Benecke, 1866)

Bivalvia (determined by I. Szente and A. Vörös):

Bakevellia ? sp.
Leptochondria ? sp.
Praechlamys sp.
Newaagia ? sp.
Mysidioptera ? sp.

Brachiopoda (determined by J. Pálfy):

Discinisca sp.
Lingula cf. tenuissima (Bronn, 1837)
Decurtella decurtata (Girard, 1843)
Volirhynchia vivida (Bittner, 1890)
Volirhynchia tommasii (Bittner, 1890)
Costirhynchopsis mentzeli (Buch, 1843)
Caucasorhynchia altaplecta (Böckh, 1872)
Piarorhynchella trinodosi (Bittner, 1890)
Sinucosta pectinata (Bittner, 1890)
Costispiriferina manca (Bittner, 1890)
Dinarispira cf. *dinarica* (Bittner, 1890)
Dinarispira avarica (Bittner, 1890)
Punctospirella fragilis (Schlotheim, 1814)
Mentzelia mentzeli (Dunker, 1851)
Koeveskallina koeveskalyensis (Stur, 1865)
Tetractinella trigonella (Schlotheim, 1820)
Schwagerispira schwageri (Bittner, 1890)
Schwagerispira cf. *mojsisovicsi* (Böckh, 1872)

Coenothyris vulgaris (SCHLOTHEIM, 1822)
Angustothyris ? *angustaeformis* (BÖCKH, 1872)
(Note: Rhynchonellid brachiopods were systematically described by PÁLFY 1988.)

Horog-hegy III + IV.

Ammonoidea (determined by A. Vörös):
Norites gondola (MOJSISOVICS, 1869)
Balatonites balatonicus (MOJSISOVICS, 1872)
Bivalvia (determined by I. Szente and A. Vörös):
Solemya cf. *abbreviata* (FRECH, 1904)
Septifer ? sp.
Protopis cf. *waageni* (SCHNETZER, 1934)
Bakevellia sp.
Cassianella sp.
Pleuronectites ? sp.
Entolium ? sp.
Newaagia ? sp.
Leptochondria ? sp.
Mysidioptera ? sp.
Myoconcha (Pseudomyoconcha) ? sp.
Unionites subrectus (BITTNER, 1901)
Schafhaeutlia ? sp.
Brachiopoda (determined by J. Pálfy):
Decurtella cf. *decurtata* (GIRARD, 1843)
Volirhynchia tommasii (BITTNER, 1890)
Volirhynchia cf. *projectifrons* (BITTNER, 1890)
Costirhynchopsis mentzeli (BUCH, 1843)
Caucasorhynchia cf. *altaplecta* (BÖCKH, 1872)
Piarorhynchella trinodosi (BITTNER, 1890)
Homoeorhynchia ? sp.
Costispiriferina manca (BITTNER, 1890)
Dinarispira cf. *dinarica* (BITTNER, 1890)
Punctospirella fragilis (SCHLOTHEIM, 1814)
Mentzelia mentzeli (DUNKER, 1851)
Koeveskallina koeveskalyensis (STUR, 1865)
Thecocyrtella horogensis n. sp.
Tetractinella trigonella (SCHLOTHEIM, 1820)
Schwagerispira schwageri (BITTNER, 1890)
Schwagerispira cf. *mojsisovicsi* (BÖCKH, 1872)
Coenothyris vulgaris (SCHLOTHEIM, 1822)
Coenothyris ? aff. *kraffti* (BITTNER, 1902)
Sulcatinella incrassata (BITTNER, 1890)
Angustothyris ? *angustaeformis* (BÖCKH, 1872)

Mencshely, Cser-tető III

Cser-tető is a small hill on the eastern side of the road between Mencshely and Nagyvázsony; it used to be a fossil hunting place for ages. The Benedictine monk and explorer RÓMER (1860, p. 180) collected "[countless, mainly smaller, entire ammonites from the boulders of the Cserjés-hegy]". The geological description by BÖCKH (1872, 1873) informs us that the "dark, very bituminous limestones" of Cser-tető provided "*Amm. Balatonicus, Amm*. cfr. *Gondola* and *Arc*. cfr. *Domatus*". The holotype of *Balatonites balatonicus* (MOJSISOVICS 1873, pl. 13, Fig. 3; 1882, pl. 4, Fig. 2) was collected here by J. Böckh.

Subsequent records in the "Balaton monograph" (DIENER 1899, 1900, ARTHABER 1903, 1911, LÓCZY 1913, 1916), refer to the extremely rich ammonoid fauna of the Reitzi Zone of Cser-tető (VÖRÖS 1998).

During geological mapping and surveys in the last two decades, G. Csillag and T. Budai, later on L. Dosztály, J. Pálfy and A. Vörös collected several well preserved specimens of *Balatonites*; one of these was figured by VÖRÖS (1998). In 2000, T. Budai, I. Szabó, I. Szente and A. Vörös made a detailed bed-by-bed collection in the section Cser-tető III.

The section

In the course of our previous and recent projects, three artificial trenches were excavated on the hill. The sections Cser-tető I and II were aimed to get better knowledge of the tuffaceous limestones of the Reitzi Zone (see VÖRÖS 1998), whereas the section Cser-tető III exposes the Pelsonian strata.

The section Cser-tető III is exposed in a 25 m long, NW to SW directed shallow artificial trench. The upper part of the grey cherty limestone beds of the Felsőörs Formation shows irregular bedding with very inconsistent dip directions. Therefore, the bed-by-bed collection was restricted to the lower 12 m thick, regularly bedded part of the exposed sequence.

The stratigraphic column of the section is shown in Figure S-4. The lowermost exposed, grey to beige, marly limestone layers are interbedded by cm-thick clay seams. Some of the well preserved ammonoids were found in these clayey interlayers. Thicker limestone beds of nodular structure follow upwards (Beds 20–22). The bituminous limestone layers (16–19) are again well bedded and contain numerous *Balatonites* specimens. Above a 1.5 m thick, poorly bedded, jointed limestone complex, laminated, bituminous limestone layers appear with mass occurrence of small *Posidonia* shells as pavements on the bedding planes (Beds 10–12). After some greyish, slightly siliceous limestone beds, from Bed 7, chert nodules and lenses become frequent and in some horizons the chert forms continuous layers.

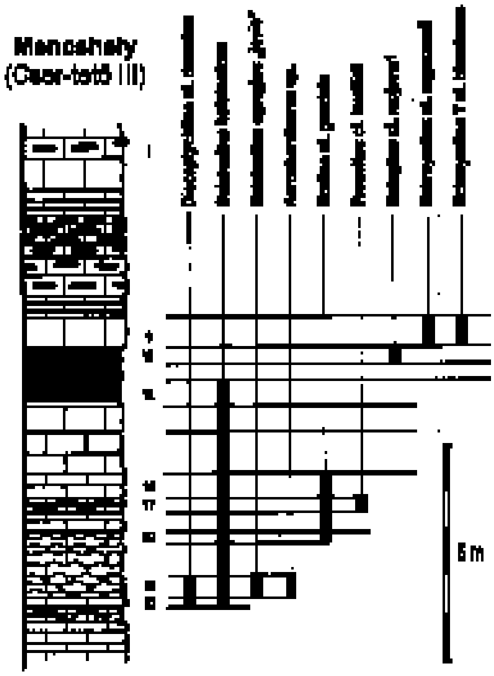

Figure S-4. The measured stratigraphical column and ammonoid range chart of the Mencshely (Cser-tető III) section (Pelsonian)
For legend see Figure S-3

Fossils

The detailed collection resulted in a rich ammonoid fauna; brachiopods and bivalves (apart from the mass occurrences of small *Posidonia*) were rarely found. A few vertebrate remains (probably ichthyosaurid vertebrae) were also collected and mass occurrence of very small gastropods in Bed 20 was recorded, but they were not identified more precisely. The determined taxa are listed below, according to systematic order. Their detailed descriptions, including specimen number data are presented in the respective chapters of this volume. Microfossils were not studied.

Ammonoidea (determined by A. Vörös):
- *Proavites hueffeli* ARTHABER, 1896
- *Proavites* sp.
- *Norites* cf. *gondola* (MOJSISOVICS, 1869)
- *Norites* sp.
- *Acrochordiceras* sp.
- *Balatonites balatonicus* (MOJSISOVICS, 1873)
- *Balatonites egregius* ARTHABER, 1896, morphotype *jovis*
- *Bulogites* cf. *mojsvari* (ARTHABER, 1896)
- *Bulogites* sp.
- *Beyrichites* sp.
- *Schreyerites ragazzonii* (MOJSISOVICS, 1882)
- *Schreyerites* ? cf. *binodosus* (HAUER, 1851)
- *Discoptychites domatus* (HAUER, 1851)
- *Discoptychites* sp.
- *Ptychites* sp.

Bivalvia (determined by I. Szente and A. Vörös):
- *Bakevellia (B.) binneyi* (BROWN, 1841)
- *Posidonia* sp.
- *Pleuronectites* ? sp.
- *Entolium* ? sp.
- *Unionites subrectus* (BITTNER, 1901)

Brachiopoda (determined by J. Pálfy):
- *Piarorhynchella trinodosi* (BITTNER, 1890)

Holcorhynchella delicatula (BITTNER, 1890)
Mentzelia cf. *mentzeli* (DUNKER, 1851)
Angustothyris ? sp.

Aszófő

This locality has been known from 1907, when, during vineyard planting, “[dark brown and greyish-yellow limestone plates with *Balatonites jubilans* and *‘Ceratites’ superbus* came to the surface]” (LÓCZY 1913, 1916).

The artificial trench was excavated by workers hired by the Geological Institute of Hungary following the instructions of I. Szabó. The detailed bed-by-bed collection was done in several phases between 1982–1986, supervised by A. Vörös. The higher part of the section (Aszófő I) was described earlier (VÖRÖS 1987). The geological description (BUDAI & VÖRÖS 1988) and biostratigraphy of the whole section was also published (VÖRÖS 1998) and a comparison with the Grossreifling sections was made by TATZREITER & VÖRÖS (1991). In the present volume, the complete fauna is revised and the biostratigraphy is re-evaluated.

The section

The locality lies 2 km north of Aszófő near the forestry road leading to Balatonszőlős. The Pelsonian sequence is exposed in two parallel, partly overlapping trenches of 50 m length.

The deepest part of the 20 m thick sequence exposed in the eastern trench (Aszófő II) belongs to the “transitional unit” between the Megyehegy Dolomite and the Felsőörs Formation (Figure S-5). Higher up the rock becomes more and more calcareous, marly and nodular; in the yellow-mottled beds (Beds II/40–42) poorly preserved, large ammonoids (*Balatonites, Acrochordiceras*) have been found. In the next few metres of the sequence greyish limestone intraclasts embedded in a yellow marly matrix prevail (Figure S-6). This “pebbly mudstone” complex is interpreted as a result of submarine gravity sliding (BUDAI & HAAS 1997). In the higher part of these resedimented beds the amount of ammonites and especially of crinoids and brachiopods rapidly increases, and the interval of Beds II/16–28 consists of “Recoaro-type” biodetrial limestone, representing the Horoghegy Member. The most common elements of the fauna are the brachiopods but ammonites and thick-shelled gastropods and bivalves are also frequent. The very diverse brachiopod assemblage is characterized by a significant percentage of disarticulated valves, and medium to large mean size of specimens. It is interpreted as a taphocoenosis, *i.e.* a mixture of brachiopods brought together from different habitats by gravitational sediment movements (PÁLFY 1986).

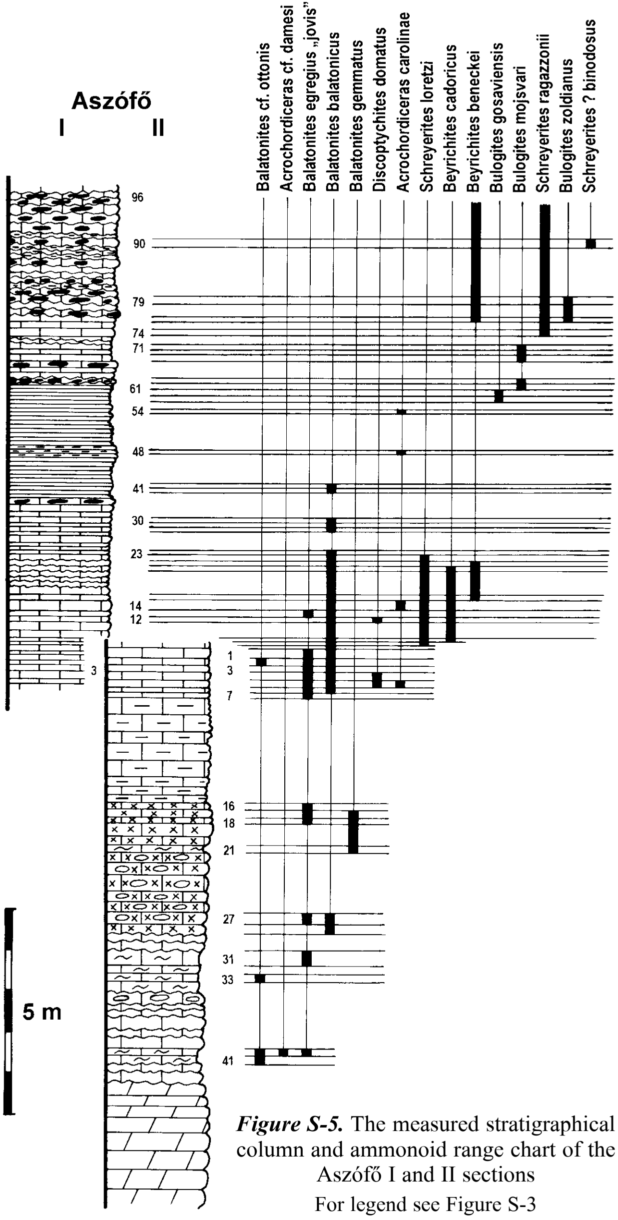

Figure S-5. The measured stratigraphical column and ammonoid range chart of the Aszófő I and II sections
For legend see Figure S-3

The upper beds of the “Recoaro-type” limestone (Beds II/17–19) form a small-scale recumbent fold which is interpreted as a slump-fold (TATZREITER & VÖRÖS 1991, BUDAI & VÖRÖS 1992). The overlying two metres of cherty limestone is poorly bedded and strongly fractured what can also be due to slumping.

With a distinct lithological change, dark-grey or dark-brown, well-bedded, sometimes laminated, highly bituminous limestone follows. The fauna is markedly different from the previous one. The ammonite assemblage is extremely rich (*Balatonites, Norites, Beyrichites, Proavites, Discoptychites, etc.*); in addition, small, thin-shelled burrowing bivalves (*Solemya, Unionites*) are rather common.

The sequence of beds continues in the other, western trench (Aszófő I; Figure S-7). The lower part (Beds I/1–40) consists of planar beds of nearly uniform thickness with marly partings on their lower division. Silicified fossils and dif-

Figure S-6. The trench Aszófő II showing the interval between Beds 1 to 34. Dashed line (below the hammer in centre) at Bed 28 marks the base of the Balatonicus Zone (= base of Pelsonian)

Figure S-7. The trench Aszófő I showing the interval between Beds 59 to 96

fuse silicification are common phenomena; from Bed I/38 upward, chert nodules appear. Between beds I/40–65, the bituminous limestone becomes finely laminated (Figure S-8), and the bedding surfaces are covered by *Posidonia* and *Daonella* shells. The undisturbed "pavements" made by the flat shells of these pelagic bivalves, the absence of benthos and bioturbation indicate anaerobic bottom conditions. Considering the absence of ammonites, it is probable that most of the water column was also oxigen-depleted.

Higher up, the burrowing bivalves reappear and the limestone becomes cherty and nodular from bed I/77 upward. This part contains rare and poorly preserved ammonites (*Bulogites, Beyrichites*) and a few brachiopods.

Fossils

The detailed collection resulted in an extremely rich ammonoid and brachiopod fauna; the gastropod, nautilid and bivalve associations are also diverse. Besides frequent crinoid skeletal elements, plant (imprints of conifer twigs), echinoid and vertebrate remains (fish and/or reptile bone fragments, teeth and scales) were found rarely but were not identified more precisely. Microfossils were determined partly from

Figure S-8. Laminated limestone beds with shaly marl interlayers. Aszófő I, around Bed 60 thin sections (foraminifers), partly isolated by dissolving (radiolarians, conodonts). The determined taxa are listed below, according to systematic order. Their detailed descriptions, including specimen number data are presented in the respective chapters of this volume (or elsewhere, if noticed).

Foraminifera:

A. ORAVECZ-SCHEFFER (pers. comm.) recognised the very important Pelsonian guide foraminifer *Paulbronnimannia judicariensis* (PREMOLI SILVA, 1971) in Bed 57 of the Aszófő I section.

Radiolaria:

Poorly preserved radiolarians were found by DOSZTÁLY (1988) in the lower part of the Aszófő I section; from beds 25–27, the following taxa were determined:
Astrocentrus sp.
Spongopallium sp.
Stylosphaera sp.
Weverisphaera sp.

Gastropoda (after VÖRÖS 1987):

Discohelix sp.
Omphaloptychia ? sp.
Trypanostylus ? sp.
Coelostylina ? sp.
Coelochrysalis ? sp.
Neritaria ? sp.
Trachynerita ? sp.
Promathilda sp.
Lepetopsis ? sp.
Undularia ? sp.
Sisenna sp.
Worthenia sp.
Natiria ? sp.
Naticopsis ? sp.
(Note: this fauna is presently under detailed revision by J. Szabó)

Nautiloidea (nautilids systematically described by VÖRÖS 2001):

Michelinoceras ? sp.
Anoploceras cf. *rollieri* (ARTHABER, 1896)
Encoiloceras balatonicum VÖRÖS, 2001
Encoiloceras lajosi VÖRÖS, 2001
Mojsvaroceras ? cf. *binodosum* (HAUER, 1887)
Pleuronautilus mosis MOJSISOVICS, 1882
Trachynautilus cf. *nodulosus* (ARTHABER, 1896)
Germanonautilus cf. *salinarius* (MOJSISOVICS, 1882)
Paranautilus cf. *indifferens* (HAUER, 1892)
Syringonautilus cf. *lilianus* (MOJSISOVICS, 1882)
Sybillonautilus cf. *pertumidus* (ARTHABER, 1896)

Ammonoidea (determined by A. Vörös):

Proavites hueffeli ARTHABER, 1896
Norites gondola (MOJSISOVICS, 1869)
Norites falcatus ARTHABER, 1896
Alanites ? sp.
Ismidites cf. *marmarensis* ARTHABER, 1915
Ismidites sp., aff. *marmarensis* ARTHABER, 1915
Acrochordiceras cf. *damesii* (NOETLING, 1880)
Acrochordiceras carolinae MOJSISOVICS, 1882
Balatonites cf. *ottonis* (BUCH, 1849)
Balatonites balatonicus (MOJSISOVICS, 1873)
Balatonites balatonicus (MOJSISOVICS, 1873) morphotype *zitteli*
Balatonites gemmatus MOJSISOVICS, 1882
Balatonites egregius ARTHABER, 1896, morphotype *jovis*
Bulogites gosaviensis (MOJSISOVICS, 1882)

Bulogites zoldianus (Mojsisovics, 1882)
Bulogites multinodosus (Hauer, 1892)
Bulogites mojsvari (Arthaber, 1896)
Beyrichites cadoricus (Mojsisovics, 1869)
Beyrichites beneckei (Mojsisovics, 1882)
Beyrichites cf. *reuttensis* (Beyrich, 1867)
Beyrichites ? sp.
Schreyerites loretzi (Mojsisovics, 1882)
Schreyerites ragazzonii (Mojsisovics, 1882)
Schreyerites sp., aff. *splendens* Arthaber, 1896
Schreyerites ? *binodosus* (Hauer, 1851)
Semiornites sp.
Discoptychites domatus (Hauer, 1851)
Noetlingites sp.

Coleoidea (determined by A. Vörös):
Mojsisovicsteuthis ? sp.
Breviconoteuthis sp.

Scaphopoda (determined by A. Vörös):
Dentalium (*Antalis*) sp.

Bivalvia (determined by I. Szente and A. Vörös):
Palaeoneilo praecursor (Frech, 1904)
“*Palaeoneilo*” *minutissima* (Frech, 1904)
Solemya abbreviata (Frech, 1904).
Parallelodon sp.
Septifer ? sp.
Mysidiella ? sp.
Protopis ? sp.
Bakevellia (*B.*) *binneyi* (Brown, 1841)
Gervillaria cf. *hartmanni* (Münster, 1834)
Cassianella praecursor Frech, 1904
Daonella boeckhi Mojsisovics, 1874
Posidonia wengensis (Wissmann, 1841)
Mysidioptera ? sp.
Plagiostoma striatum (Schlotheim, 1823)
Plagiostoma sp.
Limea (Pseudolimea) sp.
Serania ? sp.
Limidae ? gen. et sp. indet.
Pleuronenctites laevigatus (Schlotheim, 1820)
Leptochondria cf. *viezzenensis* (Wilckens, 1909)
Leptochondria ? sp.
Entolium discites (Schlotheim, 1820)
Entolium cf. *kellneri* (Kittl, 1903)
Entolioides ? sp.
Newaagia ? sp.
Myophoria cf. *proharpa* Frech, 1904
Schafhaeutlia ? sp.
Unionites subrectus (Bittner, 1901)
Pseudocorbula gregaria (Münster in Goldfuss 1838)
Pleuromya elongata (Schlotheim, 1822)

Brachiopoda (determined by J. Pálfy):
Costirhynchopsis mentzeli (Buch, 1843)
Decurtella decurtata (Girard, 1843)
Decurtella cf. *illyrica* (Bittner, 1903)
Piarorhynchella trinodosi (Bittner, 1890)
Volirhynchia projectifrons (Bittner, 1890)
Volirhynchia productifrons (Bittner, 1890)

Volirhynchia tommasi (BITTNER, 1890)
Trigonirhynchella attilina (BITTNER, 1890)
Homoeorhynchia ? sp.
Holcorhynchella delicatula (BITTNER, 1890)
Punctospirella fragilis (SCHLOTHEIM, 1814)
Mentzelia mentzeli (DUNKER, 1851)
Koeveskallina koeveskalyensis (STUR, 1865)
Koeveskallina paleotypus (LORETZ, 1875)
Tetractinella trigonella (SCHLOTHEIM, 1820)
Schwagerispira schwageri (BITTNER, 1890)
Schwagerispira cf. *mojsisovicsi* (BÖCKH, 1872)
Coenothyris vulgaris (SCHLOTHEIM, 1822)
Coenothyris cf. *kraffti* BITTNER, 1890
Coenothyris ? aff. *kraffti* BITTNER, 1902
Coenothyris cf. *cuccensis* BITTNER, 1890
Angustothyris ? *angustaeformis* (BÖCKH, 1872)
Sulcatinella incrassata (BITTNER, 1890)
(Note: Rhynchonellid brachiopods were systematically described by PÁLFY 1988.)

Conodonta (determined by S. Kovács):
Gondolella bifurcata (BUDUROV & STEFANOV, 1972)
Gondolella bulgarica (BUDUROV & STEFANOV, 1975)
Gondolella hanbulogi (SUDAR & BUDUROV, 1979)
Neospathodus kockeli TATGE, 1956
Neospathodus germanicus KOZUR, 1970
Gondolella aff. *praehungarica* KOVÁCS, 1994

Felsőörs

The Middle Triassic section at Felsőörs (also known as Forrás-hegy or Malom-völgy) is one of the most famous geological localities of Hungary, discovered by J. Böckh in 1870. The locality became a kind of sacred place of pilgrimage for Hungarian geologists and later, due to its outstanding importance for the Anisian/Ladinian boundary problem, was frequently visited by international symposia. Therefore an ample literature describing the section is available (BÖCKH 1872, 1873, LÓCZY 1913, 1916, SZABÓ *et al.* 1980, KOVÁCS *et al.* 1990, BUDAI 1991, VÖRÖS *et al.* 1996, MÁRTON *et al.* 1997, VÖRÖS 1998, VÖRÖS *et al.* 2003).

Detailed bed-by-bed collection of fossils from the Pelsonian beds was made in the scope of a "Laczkó Dezső fossil hunting campaign" sponsored by the Hungarian Natural History Museum, organised by J. Pálfy and A. Vörös in 1992.

The section

The first systematic artificial outcrops (trenches) were excavated in the 1970s, in the scope of the National Key Section Program, following the instructions of I. Szabó. Owing to its outstanding scientific value, and a possible interest for the public, the section was recently re-excavated and preserved from erosion, partly covered by shelters. It is now a protected geological conservation site and an educational geological trail. The lower part of the section is a cleaned natural outcrop on the hillside whereas in the higher part of the section the Felsőörs Formation and the overlying tuffaceous Vászoly Formation (Reitzi Zone) were excavated in artificial trenches.

The Pelsonian sequence is exposed in the lower outcrops on the hillside (Figure S-9). It starts with thick-bedded dolomicrosparite that belongs to the Megyehegy Formation (Beds 0–22). The overlying yellowish-grey bituminous, thin-bedded dolomite and clayey dolomite of restricted basin facies (Beds 23–43) represent a "transitional unit" towards the Felsőörs Formation. The next part of the section (Forráshegy Member) consists of grey, bedded limestone, in many horizons with chert nodules (Beds 44–67). Around Bed 61, the thinner, nodular limestone beds alternate with marly interlayers (Figure S-10). The high-

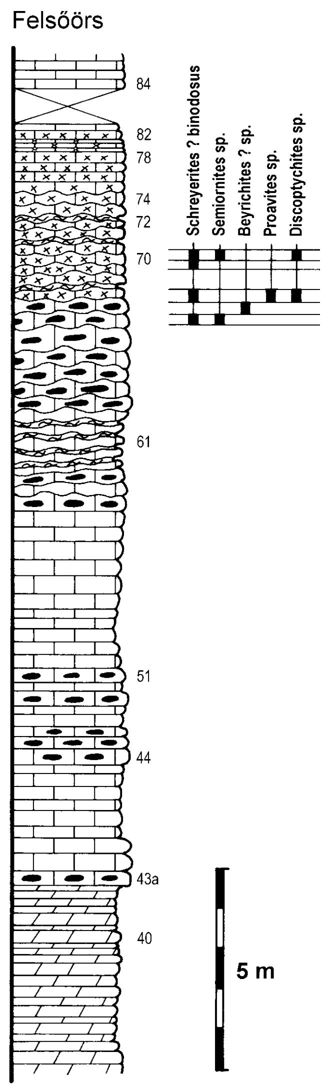

Figure S-9. The measured stratigraphical column and ammonoid range chart of the Pelsonian part of the Felsőörs section
For legend see Figure S-3

Figure S-10. The middle portion of the Pelsonian part of the Felsőörs section around Beds 60 to 70

est part of the exposed Pelsonian sequence is represented by crinoidal-brachiopodal marly limestones (Beds 68–82), that belongs to the Horoghegy Member of the Felsőörs Formation.

The microfossils and microfacies were studied by A. Oravecz-Scheffer and Gy. Lelkes (in SZABÓ *et al.* 1980), respectively.

Fossils

In the course of our detailed collecting work, a very diverse brachiopod and a poor ammonoid fauna was found in the Horoghegy Member (Beds 68–82). It is puzzling that, neither during the visits by hundreds of geologists, nor by the regular cleaning of the outcrops, nobody ever found ammonites in the deeper part of the Pelsonian sequence at Felsőörs. (The occurrence of *Balatonites margaritatus* FRECH, 1903 at Felsőörs is an enigma because the single, large specimen came allegedly from the beds of the Reitzi Zone.) The apparent absence of bivalves is also surprising.

Microfossils were determined partly from thin sections (foraminifers), partly isolated by dissolving (conodonts). The determined taxa are listed below, according to systematic order. Their detailed descriptions, including specimen number data are presented in the respective chapters of this volume (or elsewhere, if noticed).

Foraminifera: [After SZABÓ *et al.* (1980) and ORAVECZ-SCHEFFER (1987)]
- *Trochammina almtalensis* KOEHN-ZANINETTI, 1968
- *Earlandia tintinniformis* (MIŠÍK, 1971)
- *Paulbronnimannia judicariensis* (PREMOLI SILVA, 1971)
- *Endothyra salaji* GAŹDZICKI, 1972
- *Endothyra badouxi* ZANINETTI & BRÖNNIMANN, 1972
- *Endothyra obturata* BRÖNNIMANN & ZANINETTI, 1972
- *Glomospira* cf. *sinensis* HO, 1959
- *Eoophthalmidium tricki* (LANGER, 1967)
- *Planiinvoluta carinata* LEISCHNER, 1961
- *Tolypammina* ? *gregaria* WENDT, 1969
- *Placopsilina* cf. *hyrensis* (BRÖNNIMANN & ZANINETTI, 1972)
- *Ammodiscus* sp.
- *Glomospirella* sp.
- *Nodosaria* sp.
- *Lenticulina* sp.

Nautiloidea (determined by A. Vörös):
- *Germanonautilus* sp.
- *Trachynautilus* sp.

Ammonoidea (determined by A. Vörös):
- *Proavites* sp.
- *Beyrichites* ? sp.
- *Schreyerites* ? *binodosus* (HAUER, 1851)
- *Semiornites* sp.
- *Discoptychites* sp.

Ostracoda (systematically described by MONOSTORI, 1995):
- *Polycope* sp.
- *Reubenella angulata* MONOSTORI, 1995
- “*Hungarella*” *felsoorsensis* (KOZUR, 1970)
- *“Hungarella“ reniformis* (MÉHES, 1911)

“Hungarella“ anisica (KOZUR, 1970)
“Hungarella“ sp.
Bairdia cassiana rotundidorsata MONOSTORI, 1995
Bairdia finalyi (MÉHES, 1911)
Bairdia humilis MONOSTORI, 1995
Urobairdia sp.
Bairdiolites cf. *compactus* KRISTAN-TOLLMANN, 1970
Lobobairdia zapfei KOZUR, 1971
Nodobairdia ? *martinssoni* (KOZUR, 1971)
Nodobairdia sp.
Acratia cf. *goemoeryi* KOZUR, 1970
Bairdiacypris anisica KOZUR, 1971
Spinocypris vulgaris KOZUR, 1971

Brachiopoda (determined by J. Pálfy):
Decurtella decurtata (GIRARD, 1843)
Piarorhynchella trinodosi (BITTNER, 1890)
Volirhynchia vivida (BITTNER, 1890)
Volirhynchia projectifrons (BITTNER, 1890)
Caucasorhynchia cf. *altaplecta* (BÖCKH, 1872)
Trigonirhynchella attilina (BITTNER, 1890)
Mentzelia mentzeli (DUNKER, 1851)
Mentzelia balatonica (BITTNER, 1890)
Koeveskallina koeveskalyensis (STUR, 1865)
Tetractinella trigonella (SCHLOTHEIM, 1820)
Schwagerispira schwageri (BITTNER, 1890)
Schwagerispira cf. *mojsisovicsi* (BÖCKH, 1872)
Coenothyris vulgaris (SCHLOTHEIM, 1822)
Angustothyris ? *angustaeformis* (BÖCKH, 1872)
(Note: Rhynchonellid brachiopods were systematically described by PÁLFY 1988.)

Conodonta (determined by S. Kovács):
Gondolella bifurcata (BUDUROV & STEFANOV, 1972)
Gondolella bulgarica (BUDUROV & STEFANOV, 1975)
Gondolella hanbulogi (SUDAR & BUDUROV, 1979)
Gondolella aff. *praehungarica* KOVÁCS, 1994
Gondolella aff. *szaboi* KOVÁCS, 1983
Neospathodus kockeli TATGE, 1956
Neospathodus germanicus KOZUR, 1970
Gladigondolella malayensis budurovi KOVÁCS & KOZUR, 1980

IMPORTANT BOREHOLES

Several boreholes penetrated or reached Pelsonian strata at the Balaton Highland; three of these, providing important palaeontological and stratigraphical data will shortly be presented below.

Szentantalfa, Szaf–1

The borehole, drilled in 1977 with continuous core sampling (supervised by I. Szabó), penetrated Middle Triassic formations. Starting from the Füred Limestone, below the Buchenstein and Vászoly Formations, it crossed the Tagyon Limestone in more than

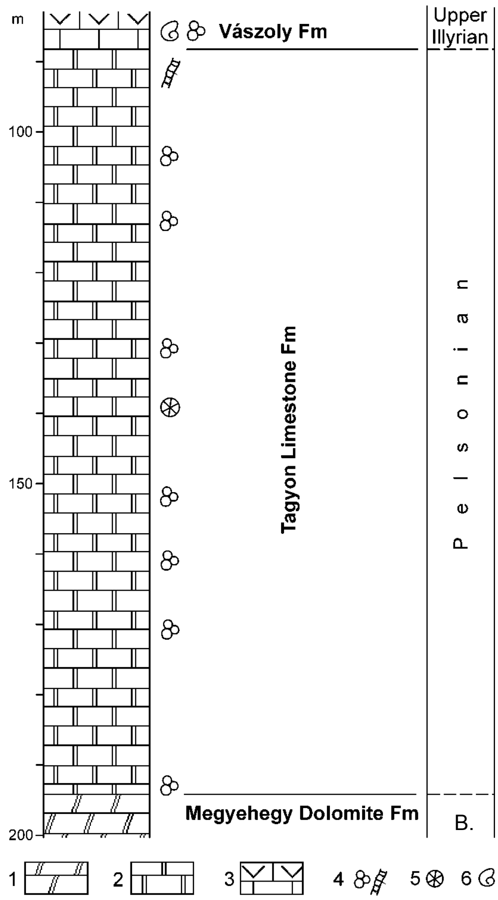

Figure S-11. Stratigraphical column of the lower part of Szentantalfa Szaf–1 borehole (after ORAVECZNÉ SCHEFFER 1980)

Legend: 1 — platform dolomite; 2 — platform limestone; 3 — limestone and tuffaceous limestone of basin facies; 4 — foraminifers, dasycladaceans; 5 — corals; 6 — ammonoids; B. = Bithynian one hundred metres thickness and ended in the Megyehegy Dolomite (Figure S-11). A short description of the section was given by ORAVECZNÉ SCHEFFER (1980).

The Pelsonian Substage is represented by the massive beds of Tagyon Limestone of subtidal to subaerial facies with frequent vadose early diagenetic overprint. The cores were cut and the thin sections were investigated for microfossils (ORAVECZNÉ SCHEFFER 1980) and for calcareous algae, sedimentary structures and microfacies (O. Piros and Gy. Lelkes in BUDAI *et al.* 1993). The cores happened to be regrettably lost but the thin section are available for further studies.

Fossils

The foraminifer fauna and the calcareous algae assemblages are exceptionally rich throughout the Tagyon Limestone. Ostracods, fragments of molluscan shells and echinoderm skeletal elements occur sporadically.

Calcareous algae (determined by O. Piros):

Oligoporella pilosa var. *pilosa* PIA ex BYSTRICKÝ, 1964
Physoporella pauciforata var. *sulcata* BYSTRICKÝ, 1962
Physoporella pauciforata var. *undulata* PIA, 1935
Physoporella pauciforata var. *pauciforata* PIA ex BYSTRICKÝ, 1964

Foraminifera (after ORAVECZ-SCHEFFER 1980):

Glomospira sinensis HO, 1959
Glomospirella elbursorum BRÖNNIMANN *et al.*, 1972
Glomospirella triphonensis BAUD *et al.*, 1971
Ammobaculites radstadtensis KRISTAN-TOLLMANN, 1964
Earlandia tintinniformis (MIŠÍK, 1971)
Earlandia amplimuralis PANTIĆ, 1972
Earlandinita oberhauseri SALAJ, 1967
Paleonubecularia minuta BRÖNNIMANN *et al.*, 1972
Endothyra badouxi ZANINETTI & BRÖNNIMANN, 1972
Endothyranella wirzi (KOEHN-ZANINETTI, 1968)
Haplophragmella inflata ZANINETTI & BRÖNNIMANN, 1973
Meandrospira dinarica KOCHANSKY-DEVIDÉ & PANTIĆ, 1966
Diplotremina astrofimbriata KRISTAN-TOLLMANN, 1960
Duostomina magna TRIFONOVA, 1974
Variostoma sp.

Dörgicse, Drt–1

The borehole, drilled in 1985 with continuous core sampling (supervised by T. Budai), penetrated the Lower Carnian Füred Limestone, the Ladinian Buchenstein and Vászoly Formations, and crossed the Pelsonian Tagyon Limestone in more than 70 m thickness. A comprehensive description of the section is given in BUDAI *et al.* 1993, 1999 (Figure S-12).

The cores of Tagyon Limestone were cut and the thin sections were investigated for microfossils (Oraveczné Scheffer, manuscript in BUDAI *et al.* 1990) and for calcareous algae and microfacies (O. Piros and Gy. Lelkes in BUDAI *et al.* 1993).

Fossils

The calcareous algae assemblages and the foraminifer fauna are extremely rich throughout the Tagyon Limestone. Ostracods, fragments of molluscan shells and echinoderm skeletal elements occur sporadically.

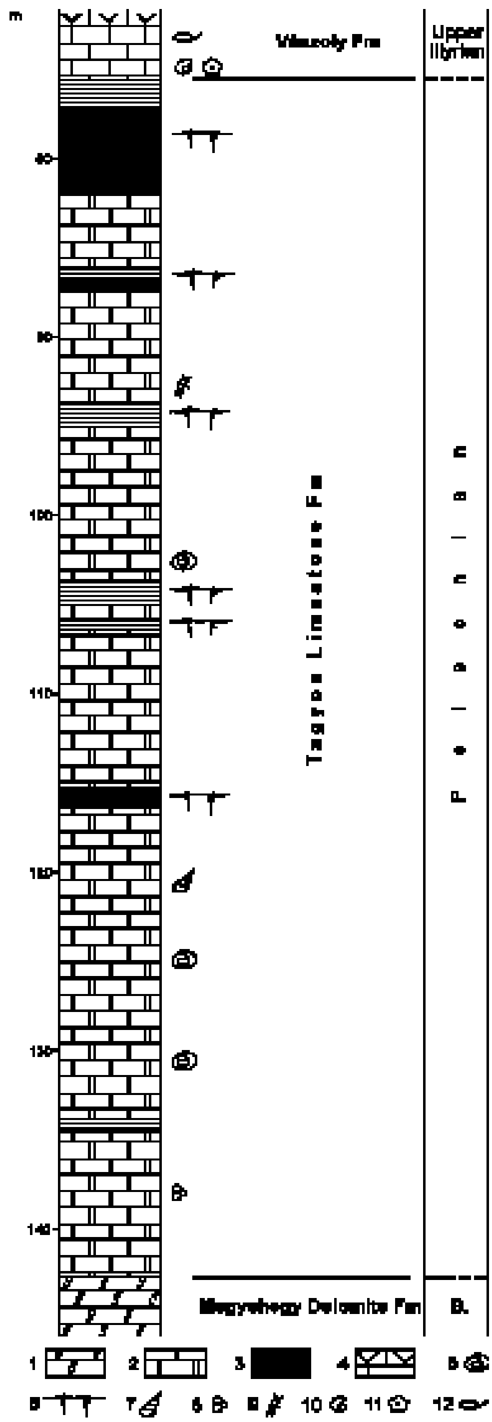

Figure S-12. Stratigraphical column of the lower part of Dörgicse Drt–1 borehole (after BUDAI *et al.* 1990)

Legend: 1 — platform dolomite; 2 — subtidal platform limestone; 3 — peritidal platform limestone; 4 — limestone and tuffaceous limestone of basin facies; 5 — oncoids; 6 — desiccation cracks; 7 — gastropods; 8 — foraminifers; 9 — dasycladaceans; 10 — ammonoids; 11 — crinoid fragments; 12 — brachiopods; B. = Bithynian

Calcareous algae (determined by O. Piros):

Teutloporella peniculiformis OTT, 1963
Physoporella pauciforata var. *undulata* PIA, 1935
Physoporella pauciforata var. *pauciforata* PIA ex BYSTRICKÝ, 1964

Foraminifera (after Oravecz-Scheffer, in BUDAI *et al.* 1990):

Calcitornella sp.
Diplotremina astrofimbriata KRISTAN-TOLLMANN, 1960
Earlandia sp.
Earlandia tintinniformis (MIŠÍK, 1971)
Earlandinita elongata SALAJ, 1967
Earlandinita sp.
Endothyra cf. *obturata* BRÖNNIMANN & ZANINETTI, 1972
Endothyra salaji GAŹDZICKI, 1972
Endothyra sp.
Endothyranella wirzi (KOEHN-ZANINETTI, 1968)
Glomospira sp.
Glomospirella triphonensis BAUD *et al.,* 1971
Haplophragmella sp.
Meandrospira ? *deformata* SALAJ, 1967
Meandrospira dinarica KOCHANSKY-DEVIDÉ & PANTIĆ, 1966
Trochammina almtalensis KOEHN-ZANINETTI, 1968

Balatonfüred, Bfü–1

This 300 m deep borehole was drilled in 1978 (supervised by I. Szabó) with continuous core sampling. It crossed the Carnian Veszprém Formation and Füred Limestone, the Ladinian Buchenstein and Vászoly Formations, penetrated the Anisian Felsőörs Formation in 70 m thickness, and ended in the Megyehegy Dolomite (Figure S-13).

The Pelsonian Substage is represented by the lower 38 m of the Felsőörs Formation. The thin sections were investigated for microfossils (ORAVECZ-SCHEFFER 1987) and sporomorphs were extracted and identified (GÓCZÁN & ORAVECZ-SCHEFFER 1993).

Fossils

The sporomorph assemblages and the foraminifer fauna are rather rich throughout the Pelsonian part of the Felsőörs Formation. Ostracods, sponge spicules, fragments of molluscan shells and echinoderm skeletal elements are also frequent but were not determined.

Sporomorpha (after GÓCZÁN & ORAVECZ-SCHEFFER 1993):

Verrucisporites div. sp.
Cyclotriletes div. sp.
Triadispora div. sp.
Uvaesporites fueredensis GÓCZÁN, 1993
Striatoabieites aytugii VISSCHER, 1966
Strotersporites tozeri BRUGMAN, 1986
Stellapollenites thiergartii (MÄDLER, 1964)
Dyupetalum vicentinense BRUGMAN, 1983

Foraminifera (after ORAVECZ-SCHEFFER 1987 and GÓCZÁN & ORAVECZ-SCHEFFER 1993):

Eoophthalmidium tricki (LANGER, 1967)
Ophthalmidium ubeyliense DAGER, 1978
Paulbronnimannia judicariensis (PREMOLI SILVA, 1971)

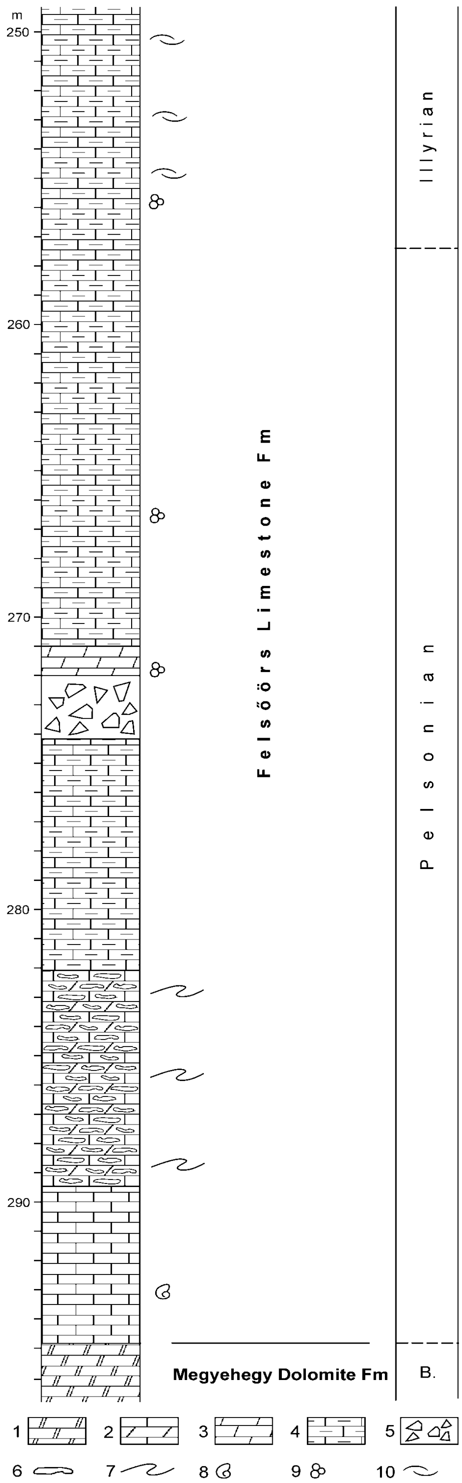

Figure S-13. Stratigraphical column of the lower part of Balatonfüred Bfü–1 borehole (after SZABÓ *et al.* 1981)

Legend: 1 — dolomite of ramp facies; 2 — limestone/dolomite alternation ("transitional member"); 3 — dolomitised limestone of basin facies; 4 — limestone and argillaceous limestone of basin facies; 5 — tectonized zone; 6 — plasticlasts; 7 — slump structures; 8 —ammonoids; 9 — forams; 10 — filaments; B. = Bithynian

Other Localities

Paloznak

The borehole Paloznak Pat–1 was drilled in 1986 with continuous core sampling (supervised by T. Budai), penetrated the Lower Carnian Füred Limestone, the Buchenstein and Vászoly Formations, the dark grey, marly limestone beds of the Anisian Felsőörs Formation and ended in the Megyehegy Dolomite.

Fossils

From the depth 125.8 m T. Budai collected a poorly preserved ammonoid, determined by A. Vörös as *Balatonites* ? sp. indet.

Veszprém

About five km to the south of Veszprém, abundant slabs of greyish, bituminous limestone lie dispersed along the road No. 73, leading to Csopak. The nearest settlement is marked on the recent maps as "Szabadság-puszta", or "Miklósháza-puszta". This locality is probably identical with the classical site "Veszprém, Alsó-erdő" of Laczkó (1911).

Fossils

From the loose rock slabs, T. Budai and A. Vörös collected several ammonoids of various state of preservation.

Ammonoidea (determined by A. Vörös):

Balatonites balatonicus (Mojsisovics, 1873)
Balatonites balatonicus (Mojsisovics, 1873) morphotype *zitteli*
Balatonites cf. *gemmatus* Mojsisovics, 1882
Discoptychites cf. *domatus* (Hauer, 1851)

Szentkirályszabadja

Near the local military airport, an abandoned quarry exposes the upper part of the massive or thick-bedded, dolomitised Tagyon Formation (Figure S-14) (the whole thickness of the formation is approximately one hundred metres). The "Tagyon Dolomite" is paraconformably overlain by brownish, dolomitised limestone beds of the Vászoly Formation of Late Illyrian age, whereas its lower boundary towards the Megyehegy Dolomite is not seen. The section was described by Budai *et al.* (1993), by Budai & Haas (1997) and more precisely illustrated by Budai *et al.* (2001) (Figure S-15).

Several pieces of the "Tagyon Dolomite" were cut and the thin sections were investigated for calcareous algae, sedimentary structures and microfacies (O. Piros and Gy. Lelkes in Budai *et al.* 1993).

Figure S-14. Thick-bedded "Tagyon Dolomite" in the abandoned quarry near the military airport at Szentkirályszabadja. The hammer in right centre marks the site of the unique find of *Balatonites balatonicus*

Fossils

The "Tagyon Dolomite" of subtidal to subaerial facies is very rich in calcareous algae. Fortuitously, O. Piros noticed two ammonoid specimens in the massive dolomite. Various bioclasts were identified in thin sections, including calcified cyanobacterial mats, dasycladaceans, unbroken gastropods, other molluscs, benthonic foraminifers, echinoderms and ostracods.

Calcareous algae (determined by O. Piros):

Physoporella varicans Pia, 1935
Physoporella pauciforata var. *pauciforata* Pia ex Bystrický, 1964
Physoporella pauciforata var. *undulata* Pia, 1935
Physoporella pauciforata var. *sulcata* Bystrický, 1962

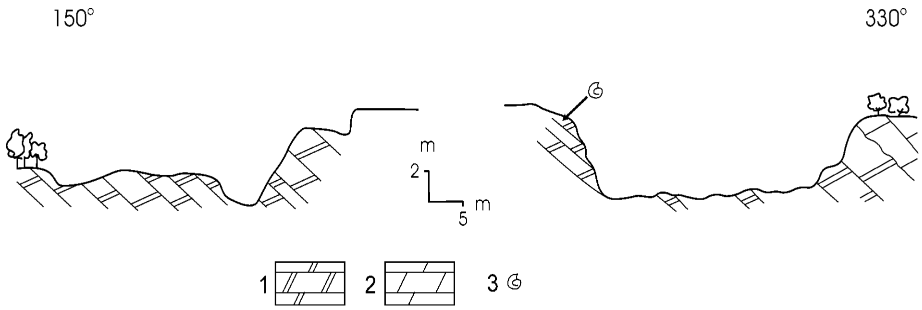

Figure S-15. Profile of the airport-quarry at Szentkirályszabadja (after BUDAI *et al.* 2001)
Legend: 1 — "Tagyon Dolomite", 2 — Vászoly Fm, 3 — *Balatonites balatonicus*

Physoporella pauciforata var. *gemerica* BYSTRICKÝ, 1962
Physoporella minutuloidea HERAK, 1967
Anisoporella anisica (ZANIN BURI, 1965) HURKA, 1969
Poncetella hexaster (PIA, 1912) GÜVENÇ, 1979
Teutloporella peniculiformis OTT, 1963

Ammonoidea (determined by A. Vörös):
Balatonites balatonicus (MOJSISOVICS, 1873)

Balatonalmádi

This section, in the road-cut between Vörösberény (Balatonalmádi) and Szentkirályszabadja (BUDAI & VÖRÖS 1989), on the slope of the Megye-hegy, was collected bed-by-bed for the Anisian–Ladinian boundary interval (VÖRÖS 1993). The uppermost part of the Felsőörs Formation (limestone beds with clay seams) is exposed in a few metres thickness and only Bed 38 seems to belong to the Pelsonian.

Fossils

Bed 38 provided a few ammonoids and a poorly preserved brachiopod fauna of low diversity.

Ammonoidea (determined by A. Vörös):
Proavites cf. *hueffeli* ARTHABER, 1896

Brachiopoda (determined by J. Pálfy):
Decurtella decurtata (GIRARD, 1843)
Volirhynchia vivida (BITTNER, 1890)
Schwagerispira cf. *schwageri* (BITTNER, 1890)

BIOSTRATIGRAPHY

AMMONOID BIOSTRATIGRAPHY
(ATTILA VÖRÖS)

Subdivision and boundaries of the Pelsonian Substage at the Balaton Highland

On the basis of the ammonoid data sets recorded in the measured sections, five successive biostratigraphical units, termed here as subzones, can be recognised and correlated within the studied stratigraphic interval of the Balaton Highland (Figure S-16, Table S-1). The names of these subzones are only partly identical with those suggested earlier by VÖRÖS (1987, 1998).

The elements of the proposed subzonal scheme, from bottom to top: Ottonis Subzone, Balatonicus Subzone, Cadoricus Subzone, Zoldianus Subzone, Binodosus Subzone. The previously defined Balatonicus Subzone is now divided into three subzones. The Zoldianus Subzone remained unchanged. The Binodosus Subzone (used as "unnamed subzone" in VÖRÖS & PÁLFY 2002) was transferred from the Trinodosus to the Balatonicus Zone. Table S-1 shows the vertical distribution of ammonoid taxa within the subzones.

The subzones can be best recognised and are most completely represented in the Aszófő section.

Ottonis Subzone. Beds II/40–41 of Aszófő provided a scarce and poorly preserved ammonoid fauna with a few specimens of *Balatonites* cf. *ottonis* and *B. egregius* morphotypus *jovis*, and a single, extremely large *Acrochordiceras* cf. *dame-*

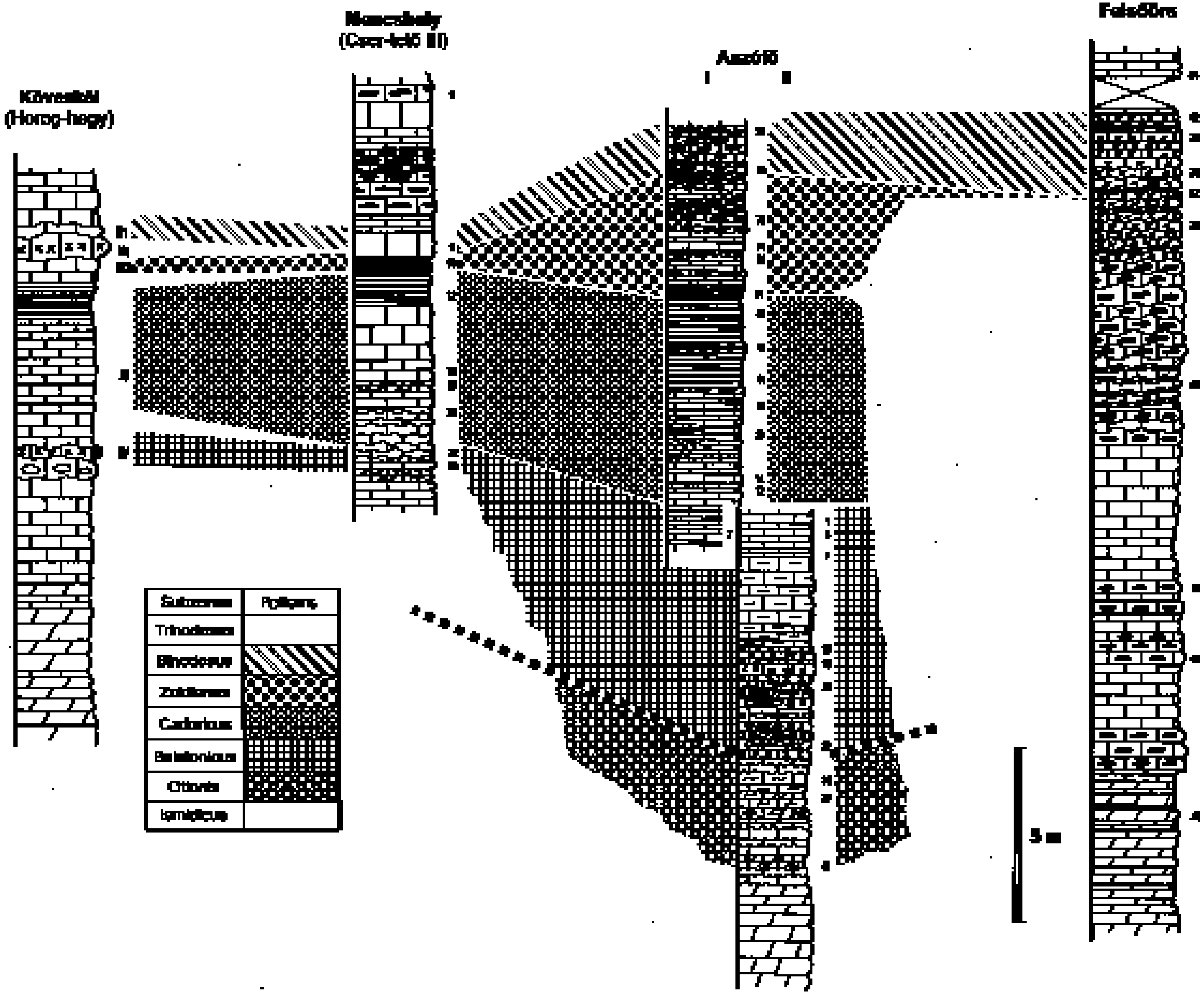

Figure S-16. The ammonoid subzones recognised in the Aszófő section and their correlation with other measured sections of the Balaton Highland
Dashed line = lower boundary of Pelsonian. For legend see Figure S–3

Table S-1. The vertical distribution of ammonoid taxa determined from the Pelsonian of the Balaton Highland within the recognised subzones

Ammonoids \ Subzones	Ottonis	Balatonicus	Cadoricus	Zoldianus	Binodosus
Acrochordiceras cf. *damesii*	■				
Balatonites cf. *ottonis*	■ ■ ■	■ ■			
Balatonites egregius m. *jovis*	■ ■ ■	■ ■ ■	■		
Noetlingites sp.		■			
Ismidites sp., aff. *marmarensis*		■			
Balatonites gemmatus		■			
Ismidites cf. *marmarensis*		■ ■ ■	■		
Balatonites balatonicus		■ ■ ■	■ ■		
Norites gondola		■ ■ ■	■ ■		
Balatonites balatonicus m. *zitteli*		■	■		
Discoptychites domatus		■	■		
Norites falcatus		■	■ ■		
Acrochordiceras carolinae		■	■ ■ ■		
Proavites hueffeli		■	■ ■ ■	■	
Alanites ? sp.			■		
Beyrichites cadoricus			■		
Schreyerites sp., aff. *splendens*			■		
Schreyerites loretzi			■ ■ ■	■ ■	
Beyrichites beneckei			■ ■ ■	■ ■ ■	■
Bulogites gosavien sis				■	
Bulogites multinodosus				■	
Bulogites mojsvari				■ ■	
Bulogites zoldianus				■	
Schreyerites ragazzonii				■ ■	■
Semiornites sp.				■ ■	■
Beyrichites cf. *reuttensis*					■
Schreyerites ? *binodosus*					■
Judicarites cf. *euryomphalus*					■

sii. This fauna can well be separated from that of the succeeding subzone containing *B. balatonicus* as well. This subzone was recognised only in the Aszófő section.

Balatonicus Subzone. The next interval of the Aszófő section, from Bed II/28 to I/7, is characterised by the continuous presence of *B. balatonicus*; furthermore *B. egregius* morphotype *jovis*, *B. gemmatus* and *Norites* species play important role. Besides the representatives of the genera *Proavites, Acrochordiceras* and *Discoptychites*, the sporadic occurrence of *Noetlingites* and *Ismidites* is worth of special attention because these genera are usually regarded as peculiar to the Bithynian faunas. This subzone can be recorded also in the lowermost part of the Mencshely section (Beds 22–23) and the "lower Recoaro" horizon of the Horog-hegy IV locality is also attributed to the Balatonicus Subzone.

Cadoricus Subzone. The almost simultaneous appearance of several taxa of Beyrichitidae (*Beyrichites cadoricus, B. beneckei, Schreyerites loretzi*) indicates the base of the next interval (between Beds I/8–58). The genus *Proavites*, *Balatonites balatonicus* and *Norites gondola* persist from the subjacent subzone, and some "Bithynian" forms (*Ismidites* cf. *marmarensis, Alanites* ? sp.) occur sporadically. This subzone is well represented in the Mencshely section (Beds 12–20), and can be recognised at Köveskál (Horog-hegy III) as well.

Zoldianus Subzone. Perhaps the most pronounced change of ammonoid faunas is connected to the base of this subzone: the long-ranging genera *Acrochordiceras, Balatonites* and *Norites* disappear and *Bulogites* appears with several species (in the order of appearance: *B. gosaviensis, B. multinodosus, B. mojsvari* and *B. zoldianus*). Other new elements of the fauna are *Schreyerites ragazzonii* and the genus *Semiornites*. This subzone comprises the interval I/59–88 in the Aszófő section, and is clearly proved (though restricted to single layer) in Mencshely (Bed 10) and in Horog-hegy II/3.

Binodosus Subzone. The uppermost beds of the Aszófő section (I/90–96) provided a scarce fauna characterised by the appearance of *Schreyerites* ? *binodosus* and *Beyrichites* cf. *reuttensis,* accompanied by *B. beneckei* and *Schreyerites ragazzonii*, which appear already in the Zoldianus Subzone. This subzone is widespread, it was recognised in Felsőörs (between Beds 72–78), Mencshely (Bed 9) and in Horog-hegy I/1, where *Judicarites* cf. *euryomphalus* also occurred. The interpretation (content) of the Binodosus Subzone is almost the same as it was described earlier by Vörös (1987 and 1998).

Correlation with other European areas

The subzones recognised in the Pelsonian of the Balaton Highland can be correlated with other European regions from the Germanic Basin to the Kocaeli Peninsula (Turkey) (Figure S-17). The figure was compiled using the stratigraphic columns and ammonoid data published by Fantini Sestini (1988), Balini (1993), Balini *et al.* (1993), Muttoni *et al.* (1998), Brack *et al.* (1999), Tatzreiter (2001) and Kozur (1974).

The **Ottonis Subzone** of Aszófő (with *Balatonites* cf. *ottonis, B. egregius* morphotypus *jovis* and *Acrochordiceras* cf. *damesii*) has its closest counterpart, naturally, at the type locality of *B. ottonis*, in the Germanic facies area. Here, especially in the Silesian Lower Muschelkalk, in the upper Gogolin Beds, other *Balatonites* (tentatively ranged to the *B. egregius* group, *e.g. B.* "*jovis*"), *Noetlingites* and *Acrochordiceras damesii* were found (Kozur 1974, Kaim & Niedźwiedzki 1999, Brack *et al.* 1999) which underline the close correlation. This horizon ("Assemblage-Zone mit Myophoria vulgaris, Beneckeia buchi und Dadocrinus") was placed into the Lower Anisian ("Hydasp"), *i.e.* Bithynian by Kozur (1974).

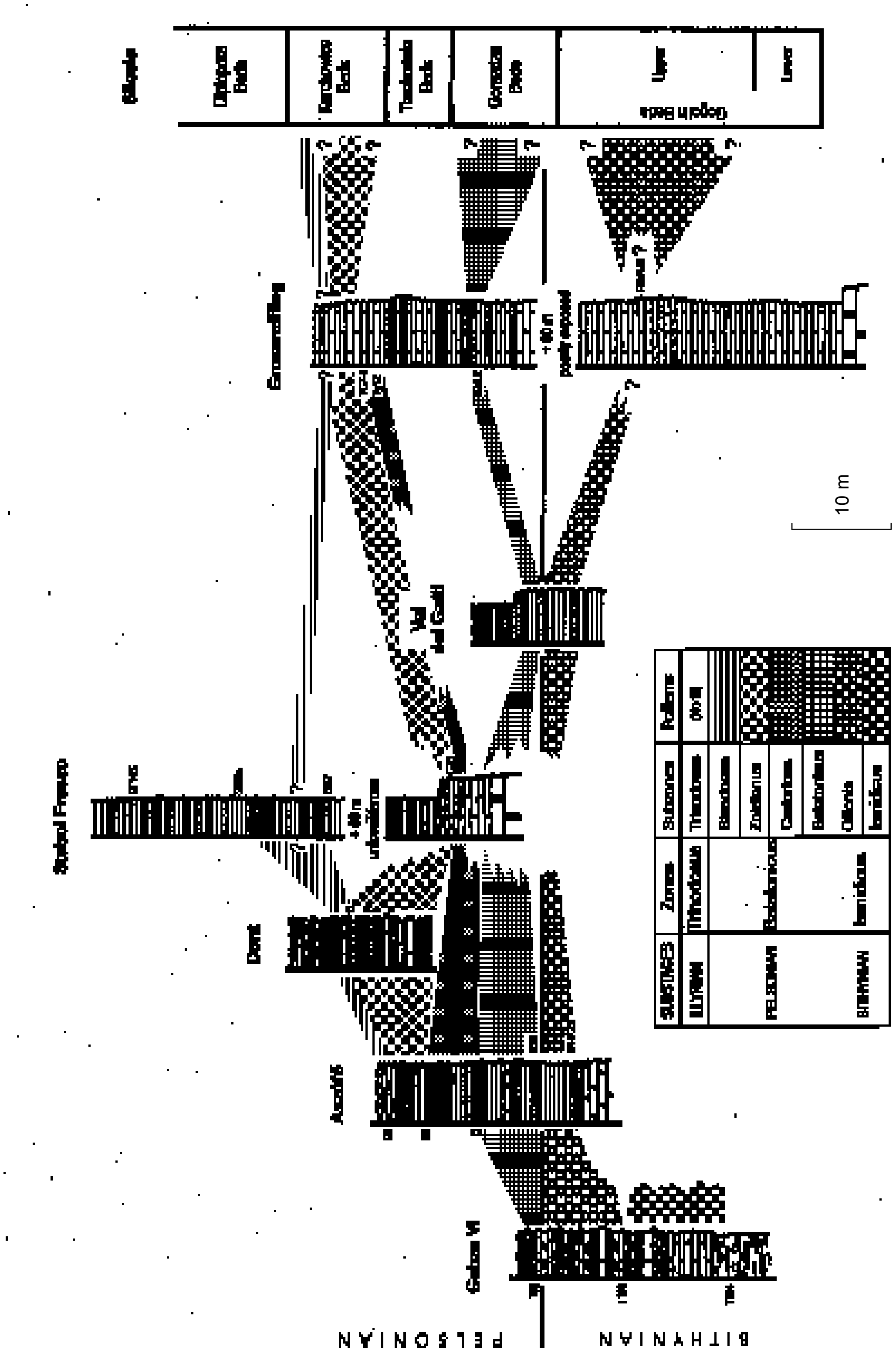

Figure S-17. Correlation of upper Bithynian and Pelsonian ammonoid subzones between some important Anisian sections of the western Tethys and the Germanic Basin

A similar fauna with *Balatonites ottonis* group and *Acrochordiceras* was found in the Angolo Limestone of Lombardy (Schilpario, Val dei Gatti) by BRACK *et al.* (1999); they correlated this horizon with that in the upper Gogolin Beds.

The Ottonis Subzone was also recognised in Turkey (Kocaeli Peninsula, Bay of Izmit), where, in the section Gebze VI, measured by ASSERETO (1974) and FANTINI SESTINI (1988), at least the beds T 160 and T 161 are attributed to here.

In the classical Grossreifling section, the Rahnbauerkogel level (RK/A-D in TATZREITER 2001) with the rich *Balatonites egregius* fauna may also correspond to the Ottonis Subzone. Based on the new finding of *Noetlingites strombecki* in this horizon, and recognition the affinity of some Silesian Lower Muschelkalk *Balatonites* (RASSMUSS 1915, KAIM & NIEDŹWIEDZKI 1999) to *B. egregius*, TATZREITER (2001) put this level to the Bithynian (Ismidicus Zone).

The **Balatonicus Subzone** of Aszófő, defined by the FAD of *B. balatonicus* (accompanied with a diverse ammonoid fauna) can be recognised in the Bed T 63 of the section Gebze VI, by the single occurrence of the index species.

The Balatonicus Subzone is suspected in the highest beds of the Angolo Limestone in the Val dei Gatti section and in the transitional beds above the Dosso dei Morti Limestone in the Stabol Fresco section (Lombardy).

In the Grossreifling section, the faunal horizon TG/L 2 is attributed to the Balatonicus Subzone, on the basis of *B.* ex gr. *balatonicus* and *B.* cf. *hystrix*. The single *Bulogites* (TATZREITER 2001) is a juvenile specimen and may rather be a *Reiflingites.*

The Balatonicus Subzone gives another correlation possibility with the Germanic facies area, namely with a part of the Górażdże Beds in Silesia, where *Balatonites*, younger than *B. ottonis* or the *egregius* group, were found (ASSMANN 1937). One of these (*B. nobilis* ASSMANN, 1937) may be closely related to *B. balatonicus*. These *Balatonites* species were listed by KOZUR (1974) among the fossils of the "Decurtata-Zone" of Pelsonian age.

The **Cadoricus Subzone** of Aszófő, comprising many surviving faunal elements of the Balatonicus Subzone, and defined by the appearance of the index species and *Schreyerites loretzi*, has rather limited record outside the Balaton Highland.

This subzone and the higher Pelsonian intervals did not yield ammonoids in the Gebze sections and in Silesia.

Some beds above the Dosso dei Morti Limestone in the Stabol Fresco section may belong to the Cadoricus Subzone on the basis of the occurrence *Balatonites* cf. *balatonicus* (BRACK *et al.* 1999) and of *Beyrichites* cf. *cadoricus* (BALINI *et al.* 1993), though this latter was found in the same layer with *Bulogites* aff. *zoldianus* (GAETANI 1969).

In the Tiefengraben section of Grossreifling, the horizons TG 7–8 and TG 12 probably belong to this Subzone as suggested by the presence of the *Balatonites balatonicus* group and the absence of *Bulogites*.

The **Zoldianus Subzone** of Aszófő, defined practically by the range of the genus *Bulogites*, can be properly correlated with the lower part of the Dont section in the Dolomites (Italy), where BALINI (1993) and MUTTONI *et al.* (1998) recorded *Bulogites* from Bed C to T, with mass occurrence of *B. zoldianus* in Bed R.

In the Stabol Fresco section, Bed G25 yielded *Bulogites* aff. *zoldianus* (GAETANI 1969, BALINI *et al.* 1993) and although it was found together with *Beyrichites* cf. *cadoricus*, this layer may indicate the base of the Zoldianus Subzone.

The uppermost fossiliferous beds (TG 1 to TG 3/4) of the Tiefengraben section at Grossreifling provided a rich assemblage of *Bulogites*, and was previously correlated with the Zoldianus Subzone of Aszófő by TATZREITER & VÖRÖS (1991) as well.

The genus *Bulogites* was frequently recorded in the Germanic Lower Muschelkalk (URLICHS & MUNDLOS 1985). The Karchowice Beds of Silesia yielded *B. zoldianus* as well (ASSMANN 1937). KOZUR (1974) listed *B. zoldianus* among the important fossils of the Pelsonian "Decurtata-Zone".

The **Binodosus Subzone**, as based on the FAD of the index species, accompanied by *Beyrichites reuttensis* and *Judicarites* was recognised in all four measured sections at the Balaton Highland. However, its applicability elsewhere in Europe seems to be very ambiguous.

The taxonomic interpretation of the index species is frustratingly contradictory. TATZREITER & BALINI (1993), when erecting the new genus *Schreyerites*, intentionally excluded the species *Ceratites binodosus* (HAUER, 1851) and BALINI (pers. comm. 2002) still holds this opinion. On the other hand, MIETTO & MANFRIN (1995) found the suture of their *"C." binodosus* as a proper basis for assigning this species to *Schreyerites*. Better than nothing, this wider interpretation is tentatively used in the present work.

The stratigraphic occurrence of *"C." binodosus* in the important Anisian reference section of Dont is also debated. BALINI (1993) found it in the level β [corresponding to the upper part of Niveau 3 of ASSERETO (1971), and to the Binodosus Subzone of VÖRÖS (1987 and this work)], and this record is subsequently confirmed (MUTTONI *et al.* 1998, BALINI, pers. comm. 2002). On the other hand, MIETTO & MANFRIN (1995, and pers. comm. 2002) collected their *"C." binodosus* from the lower level R [corresponding to the lower part of Niveau 3 of Assereto (1971), and to Zoldianus Subzone of VÖRÖS (1987, and this work)]. The arguments of both groups of authors are reasonable, but the proper documentation (monographic descriptions or at least detailed logs with range charts) is still lacking in both cases. Therefore, the correlation of the Binodosus Subzone of Aszófő with horizon β of the Dont section is doubtful, because there the range of *S.* ? *binodosus* may partly overlap the *Bulogites* range.

The correlation with the interval SF67 to SF85b of the Stabol Fresco section is also dubious, because *Judicarites* is the single ammonoid taxon indicating the presence of our Binodosus Subzone there.

From the uppermost fossiliferous layers of the Tiefengraben section at Grossreifling (TG 1 and TG 1/2) "*Ceratites* sp. (sensu *C. binodosus* ARTH. 1896)" was doubtfully recorded (TATZREITER 2001). This would imply overlapping ranges of "*binodosus*" and *Bulogites*.

The alleged occurrence of the index species in the Germanic Basin (*e.g.* "*Ceratites gorasdzensis* ASSMANN, 1937, in KOZUR 1974) does not seem to be endorsed. On the other hand, the other guide fossil of our Binodosus Subzone, the genus *Judicarites* occurs frequently in the uppermost Lower Muschelkalk (BRACK *et al.* 1999) deserving an independent "Assemblage-Zone mit Judicarites und Neoschizodus orbicularis" in KOZUR (1974).

Table S-2. The supposed relationship between the proposed subzonal scheme and those suggested in the last decades

Vörös (1987)	Present work	Mietto & Manfrin (1995)
Binodosus	Binodosus	Abichi
Zoldianus / Superbus	Zoldianus	Binodosus
Balatonicus	Cadoricus	Balatonicus
	Balatonicus	
	Ottonis	? Cuccense ?

The record of *S.* ? *binodosus* from Gebze (Turkey) by FANTINI SESTINI (1988) is taken as doubtful because the suture of the figured specimen is ceratitic, not of *Schreyerites* type, and because the specimens were found in the deeper levels of the sections, together with *Balatonites ottonis*-like forms.

The subzones defined at the Balaton Highland are believed to partly differ from, partly correspond to the subzones proposed by MIETTO & MANFRIN (1995). The supposed relationship of the subzones, along with those suggested by VÖRÖS (1987), is shown in Table S-2.

Correlation outside Europe

Representatives of the genus *Balatonites*, as the most convenient, indicative marker of the Pelsonian in wide sense, have been found at many places in South Asia, along the Alpine–Himalayan mountain ranges, including Tibet (GU *et al.* 1980) and Thailand (KUMMEL 1960); the farthest, well known record being in North America (Nevada: BUCHER 1992).

GU *et al.* (1980) regarded the fauna found at Doilungdeqen as Late Anisian (Trinodosus Zone). However, many ammonoid taxa, described and figured by them, seem rather typical Pelsonian elements [*e.g. Proavites hueffeli* ARTHABER, *Acrochordiceras carolinae* MOJSISOVICS, *Bulogites gosaviensis* (MOJSISOVICS) (as *Reiflingites* in GU *et al.*) and *Balatonites egregius* ARTHABER, morphotype *jovis* (as *B. balatonicus* in GU *et al.*)]. Therefore, agreeing with BUCHER (1992), at least a part of the Doilungdeqen fauna must be considered to be Pelsonian. Detailed stratigraphy of the locality and range charts were, however, not published, therefore a direct correlation with the Balaton Highland sections is not possible.

The best documented counterpart of the Alpine Pelsonian is known in Nevada (North America). After the early finds of *Balatonites* by HYATT & SMITH (1905), the Shoshonensis Zone was recently revised by BUCHER (1992). Apart from the majority of the ammonoid species apparently endemic in North America, there are important elements common with those of the Balaton Highland fauna. The species of the genus *Balatonites, B. shoshonensis* HYATT & SMITH and *B. whitneyi* BUCHER, appear in two distinct subzones. *Acrochordiceras carolinae* MOJSISOVICS ranges through the Shoshonensis Zone. *Ismidites* cf. *marmarensis* ARTHABER occurs only in the lowermost subzone, while *Bulogites* cf. *mojsvari* (ARTHABER) appears in the uppermost subzone. These distributions fit rather well to those found in the Aszófő section; only the Binodosus Subzone of the Balatonicus Zone does not seem to be represented in the fauna of the Shoshonensis Zone. Based on these scarce data it is supposed that the Shoshonensis Zone corresponds to the major (lower) part of the Balatonicus Zone.

Boundaries of the Pelsonian Substage

The **lower boundary** of the Pelsonian Substage is drawn between the Ottonis and Balatonicus Subzones, at the FAD of *Balatonites balatonicus, i.e.* at Bed II/28 of the Aszófő section. This concept is justified by the inter-regional correlation presented above (Figure S-17). Especially the practice developed in some classical regions and sections was taken as decisive. In the Germanic facies area, the horizons containing the early *Balatonites* (*i.e.* the *B. ottonis*-group of BRACK *et al.* 1999) is definitely ascribed to the uppermost Lower Anisian ("Hydasp" = Bithynian) (KOZUR 1974). Similarly, the new results from the Grossreifling section led TATZREITER (2001) to assign the Rahnbauerkogel horizon (correlated here with the Ottonis Subzone of Aszófő) to the Bithynian.

This judgement would put an end to the previous, common practice of using the appearance of the genus *Balatonites* as a marker of the base of the Pelsonian.

[It is worth saying some words about the alleged occurrence of the genus *Cuccoceras* at certain localities of the Balaton Highland, what would indicate the presence of the Bithynian Substage (LÓCZY 1916, pp. 111 and 113, in faunal lists). The original specimens, kept in the collections (National Geological Museum, Budapest), were examined and turned out to be small inner whorls (nuclei) of *Balatonites*.]

The suggested **upper boundary** of the Pelsonian Substage should be drawn above the Binodosus Subzone, at the FAD of *Paraceratites trinodosus*. For the time being, this boundary can not be pinpointed at the Balaton Highland, because detailed collection has not been possible in the relevant parts of the measured sections. Although *P. trinodosus* was recorded in several localities (Köveskál, Felsőörs, Vörösberény, *etc.*, see VÖRÖS 1998, VÖRÖS & PÁLFY 2002), the transitional beds from the Binodosus to the Trinodosus Subzone were unfossiliferous or not well exposed. Due to its scanty fossil record in this interval, the Dont section is also not suitable in this respect. The Giudicarie sections (*e.g.* Stabol Fresco, BALINI *et al.* 1993) seem to be best suited for drawing this boundary, *i.e.* the base of the Trinodosus Subzone.

CONODONT BIOSTRATIGRAPHY
(SÁNDOR KOVÁCS)

Introduction

Systematic conodont studies were carried out in two Pelsonian measured sections at the Balaton Highland. In 1978, the Felsőörs section, renewed at that time, was sampled bed-by-bed, including the Pelsonian part (Beds No. 43a and 44 to 83). The preliminary results are included in the contribution by SZABÓ *et al.* (1980). In the same year a small trench at Aszófő existing at that time and corresponding to the uppermost part of the present day Aszófő II section, exposing the main level with the *Balatonites balatonicus* fauna, was sampled (Beds No. 1–9/1978 from top to down). The whole Aszófő I and II sections were sampled in 1990 (not all beds). On the conodont chart of Figure S-18, S-19 only those samples are shown, which yielded determinable conodonts.

Distribution of conodonts

Felsőörs (Figure S-18)

The basal part (Beds No. 43a, 44–53) of the cherty limestone member contains a fairly rich, almost monospecific *Gondolella bulgarica* conodont fauna (see Table C-1 in KOVÁCS, this volume), represented mostly by medium ontogenetic stages. Juvenile forms are less frequent. Subadult and adult forms also occur. Part of these latters, according to the morphological criteria by KOVÁCS & PAPŠOVÁ (1986), correspond to *G. hanbulogi* and *G. bifurcata*. However, many specimens of the medium ontogenetic stage having a pointed out platform end, thus corresponding to *G. bulgarica* according to that criteria, have platform margins tending to be parallel, thus showing a transitional feature to *G. bifurcata*. In bed No. 53 the first representative of *Neospathodus kockeli* was found.

Beds No. 54–60 are very poor in conodonts.

In the higher part (Beds No. 61–68) of the cherty limestone member *G. hanbulogi* and *G. bifurcata* becomes more frequent on the expense of *G. bulgarica*.

In the "Recoaro-type" crinoidal–brachiopodal limestone member (Beds No. 69–80) of slope facies large, massive adult and hyperadult forms of *G. bifurcata* become absolutely predominating, represented by hundreds of specimens in each bed. The lowermost beds (No. 69 and 70) of this member are still characterized by primitive forms of this species. Most of the specimens, even higher up in the section, have no bifurcation of the carina posteriorly, but do have a rounded platform end and characteristically thickened platform margins. Typical forms according to BUDUROV & STEFANOV (1972), with

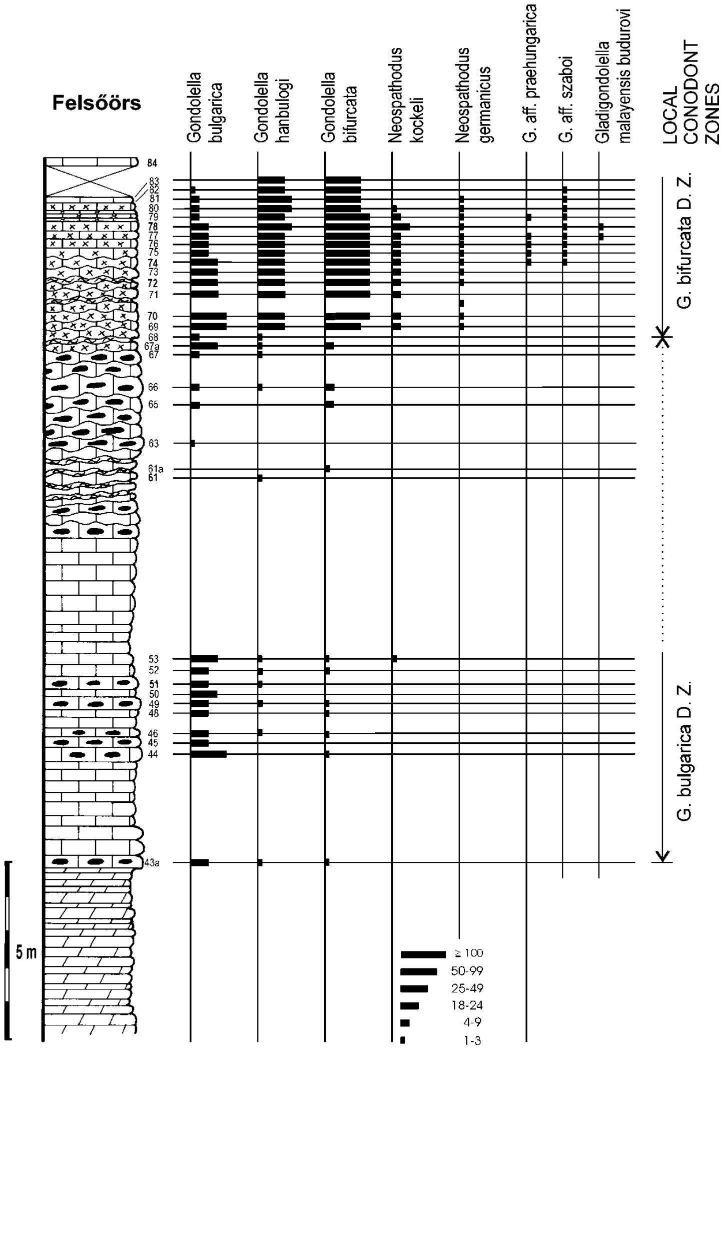

Figure S-18. Frequency distribution of of platform conodont taxa in the Felsőörs section, showing the extent of the two conodont dominance zones For legend see Figure S-3 bifurcated posterior end of carina, are also found, such as asymmetrical ones having only on one side posteriorly an accessory denticle. (The latters were identified in SZABÓ *et al.* (1980), pp. 794–795 and Pl. 59, figs. 12–13 as *"Gondolella prava"* KOZUR 1968 and *"Paragondolella bifurcata"* BUDUROV & STEFANOV (1972) was regarded as junior synonym of the former.)

G. bulgarica and *G. hanbulogi* are subordinate in this member and are represented mostly by smaller forms (medium and subadult ontogenetic stages). The former becomes rarer and rarer higher up; its last few representatives were found in Bed No. 81. Although this frequency trend of *G. bulgarica* against *G. bifurcata* and *G. hanbulogi* corresponds to the general evolutionary trend (cf. BUDUROV 1975; BUDUROV *et al.* 1983), the environmental control on the overrepresentation of large, massive forms of *G. bifurcata* is obvious.

Neospathodus germanicus and *N. kockeli* can be usually found in small number throughout the crinoidal–brachiopodal limestone member; the last representative of the former was found in Bed No. 81 (see in SZABÓ *et al.* 1980, Pl. 59, Fig. 4).

Although mass occurrence of eupelagic conodonts in the basinal facies of Balaton Highland took place much higher, *e.g.* in the Avisianum Subzone (in sense of VÖRÖS 1998) of the Reitzi Zone (KOVÁCS 1993, 1994), ramiform elements of the *Gladigondolella* apparatus can be found very rarely in this slope facies. Even one or two juvenile specimens of *Gladigondolella budurovi* were found in Beds No. 77–78. Rare occurrence of representatives of the *G. szaboi – G. trammeri* lineage indicates also slight eupelagic influence: they occur from Bed No. 74 upward in all beds. GERMANI (2000) reported from about the same interval the occurrence of *G. praeszaboi bystrickyi* and *G. praeszaboi praeszaboi* (described in KOVÁCS *et al.* 1996) in the South Alpine sections. However, our forms have a laterally more compressed platform and seem to be closer to *G. szaboi* (for description of which see KOVÁCS 1994). Therefore they are assigned to „*G.* aff. *szabói*" herein. More strangely, from Beds No. 74 to 79 rare forms resembling in the outline of the posterior platform end *?G. praehungarica* KOVÁCS, 1994 (and/or *"Neogondolella" aequidentata* KOZUR, 1995) were found. In shape of the platform they would correspond to *G. hanbulogi*, however, the cusp is not in terminal position, but there are still two smaller denticles behind it. (An "aborted" evolutionary event, homeomorphic to the Ladinian raise of *?G. praehungarica*?) They are assigned as *G.* aff. *praehungarica* herein.

The uppermost two beds of the section (No. 82 and 83), already free of crinoids and brachiopods, contain only *Gondolella bifurcata* and some *G. hanbulogi*. Conodonts are less frequent here (several tens of specimens in both samples).

On the basis of distribution of conodonts two dominance zones can be recognised in the Felsőörs section: a Gondolella bulgarica Dominance Zone comprising the interval between Beds No. 43a to 53 (or higher up to Bed 68), and a Gondolella bifurcata Dominance Zone from Bed 69 upwards (Figure S-18).

Aszófő II section (Figure S-19)

The first positive sample, Bed No. 41, yielded mostly specimens of *Gondolella bulgarica*, but besides them, *G. hanbulogi* and *G. bifurcata* also occurred (the number of specimens is shown on Table C-2 in KOVÁCS, this volume). The highest part of the section, *i.e.* the main horizon of with *Balatonites balatonicus*, yielded only a few conodonts (probably due to the unsuitable quality of acetic acid used for dissolution). A short, small trench existed in the time of the sampling in 1978, exposing this part of the section and sampled bed-by-bed (samples Af–1–9/1978, Figure S-20). All samples yielded 50–100 or even more platform conodont specimens. *G. bulgarica* and primitive representatives of *G. bifurcata* predominate over *G. hanbulogi* in each sample. A few specimens of *Neospathodus germanicus* and *N. kockeli* were also found in the latter samples.

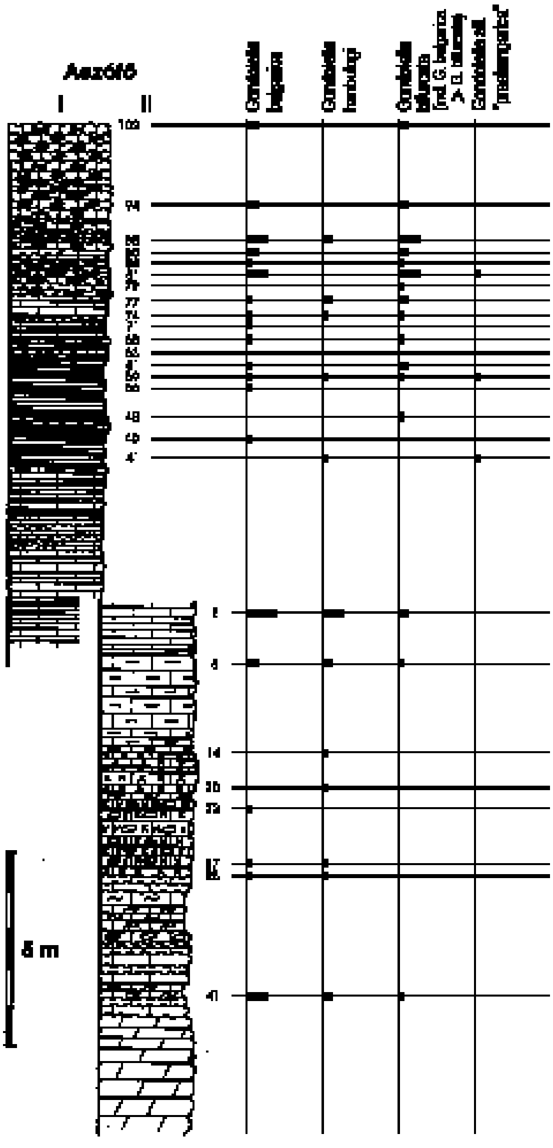

Figure S-19. Frequency of platform conodonts in the Aszófő sections (from the sampling in 1990)
For scale bars see Figure S-18, for legend see Figure S-3

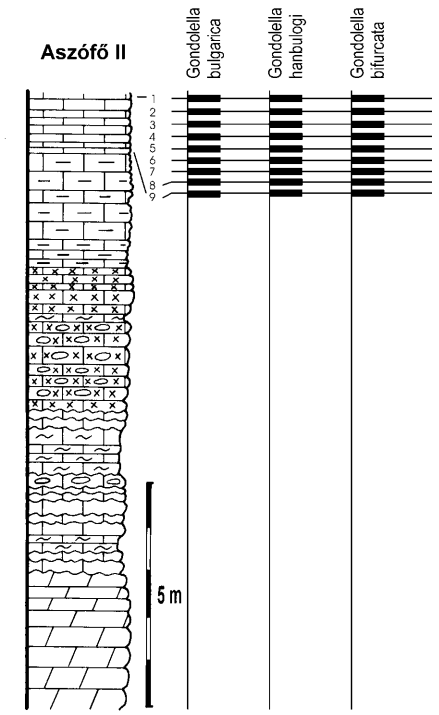

Figure S-20. Frequency distribution of conodont species in the uppermost part of the Aszófő II section (from the sampling in 1978)

Due to the relatively small specimen number of conodonts, the dominance zones recognised in Felsőörs, can not be ascertained in the Aszófő sections.

Correlation

The conodont data suggest, that the basal part of the conodont bearing basinal facies in the Felsőörs section (Beds No. 43a, 44–53) is probably older, than the first bed of basinal facies in the Aszófő II (Bed No. 41), which yielded also representatives of *Balatonites*, unless this difference in conodont distribution is not linked to the difference in facies.

Higher up, however, in the intervals of the Balatonicus, Zoldianus and Binodosus Subzones, the facies control on the distribution of *Gondolella bulgarica*, *G. hanbulogi* and *G. bifurcata* is evident, *i.e.* these ammonoid subzones cannot be distinguished by means of conodonts.

Primitive forms of *G. bifurcata* are common in the main Balatonicus horizon of Aszófő II section (Beds No. 1–7), whereas in the Felsőörs section they are characteristic for the basal part of the crinoidal–brachiopodal limestone mem-

Aszófő I section (Figure S-19)

Conodonts from samples below the Bed No. 41 of this section have not been found. Nevertheless, no significant difference is likely between the top part of the eastern section and the higher part of this section above bed No. 41. Samples from Bed No. 41 to 102 yielded specimens of both *Gondolella bulgarica* and *G. bifurcata,* largely in the same number (see Table C-2), and subordinately of *G. hanbulogi. G. bifurcata* is represented mostly by forms of juvenile and more frequently of medium ontogenetic stages; massive, adult forms which are characteristic in the crinoidal–brachiopodal limestone of the Felsőörs section are missing here. Transitional forms between *G. bulgarica* and *G. bifurcata* are common. *Neospathodus germanicus* and *N. kockeli* are very rare. Rare forms corresponding to *"G.* aff. *praehungarica"* mentioned in the Felsőörs section, were also found in Beds No. 41, 59 and 81.

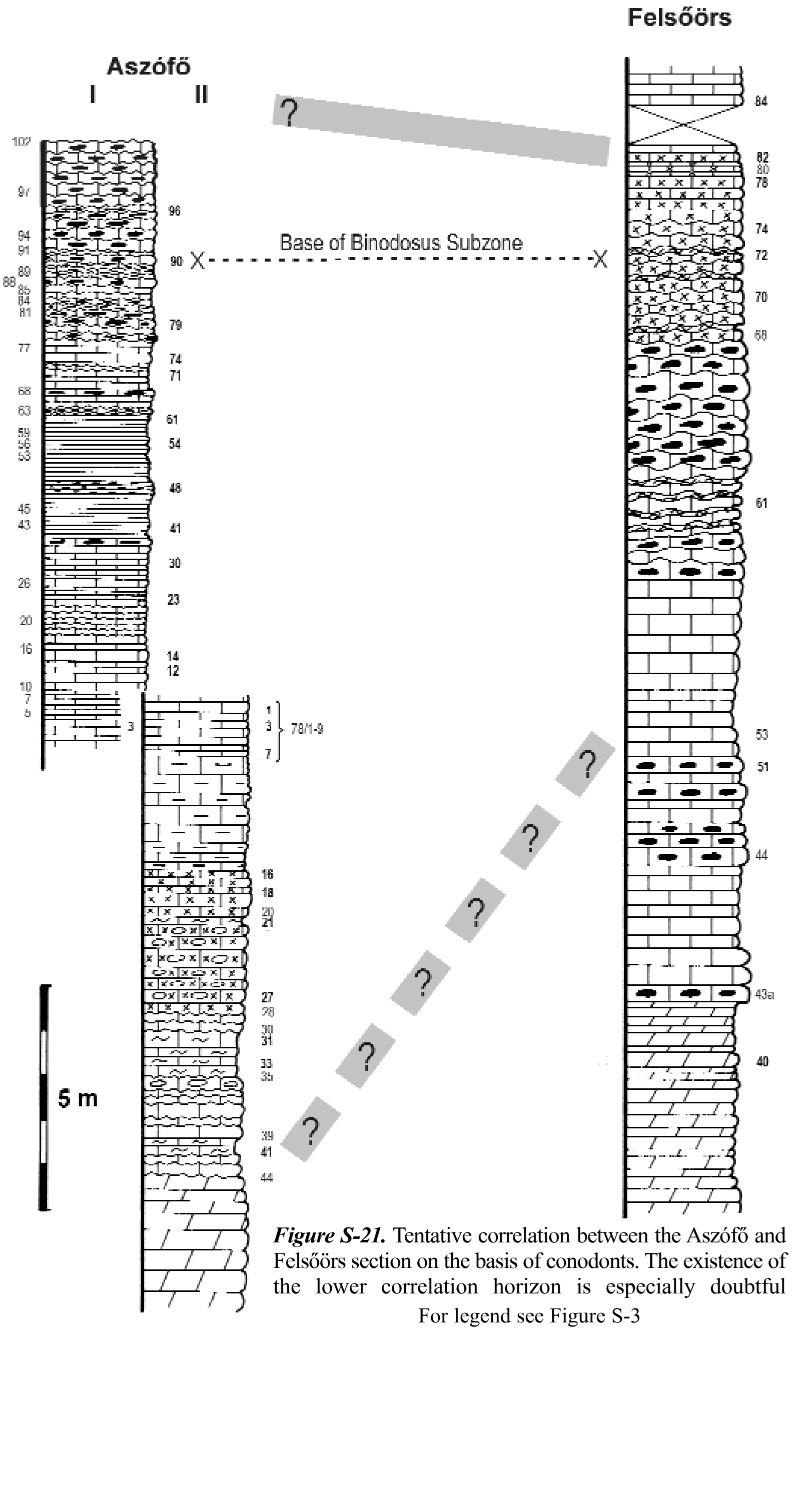

Figure S-21. Tentative correlation between the Aszófő and Felsőörs section on the basis of conodonts. The existence of the lower correlation horizon is especially doubtful For legend see Figure S-3 ber (Beds No. 69–70). However, a correlation between these horizons on the basis of conodonts is unrealistic, as in Bed No. 72 of the Felsőörs section already *Schreyerites*? *binodosus* was found.

Stratigraphically the most important result of our studies is the documentation of the joint occurrence of *Gondolella bulgarica* and *Schreyerites*? *binodosus*. In the Aszófő I section the latter was found in Bed No. 90, whereas the former up to Bed No. 102. In the Felsőörs section *S.* ? *binodosus* was found from Bed No. 72 to 78, whereas *G. bulgarica* up to Bed No. 80. The latter does not occur in the two, uppermost thin beds (No. 81 and 82) of the section.

Correlation between the Aszófő and Felsőörs sections by means of conodonts stands on rather weak grounds (Figure S-21). The highest part of the Pelsonian sequence in the Felsőörs section may correspond to the Bed 102 of Aszófő I section (not collected for ammonoids), and this horizon may lie close to the base of the Illyrian. An even more vague correlation may be supposed between the lower parts of the two section, namely Bed 41 of Aszófő II seems to be younger than Bed 53 of Felsőörs.

Discussion

Although Germani (2000), applying the morphological criteria by Kovács & Papšová (1986), unambigously documented the co-occurence of *Gondolella bulgarica*, *G. hanbulogi* and *G. bifurcata* in the eupelagic facies of Kocaeli Peninsula, NW Turkey, from the middle part of the Osmani Zone, *i.e.* from the beginning their ranges, an early G. bulgarica Dominance Zone can be still recognized in some of the sections studied in Hungary. These include the basal part of the cherty limestone in the Felsőörs section (Kovács, 1991 and in Márton *et al.* 1997), and several eupelagic sections of Aggtelek–Rudabánya Mts, NE Hungary (Kovács *et al.* 1989). This stratigraphic level may be older, than the Balatonicus Zone s.s., but in the lack of ammonoid data this cannot be proved.

The documentation of the joint occurrence of *Gondolella bulgarica* and *Schreyerites* ? *binodosus* in the Aszófő and Felsőörs sections is of prime importance. In the Felsőörs section *S.* ? *binodosus* was found from Bed No. 72 to 78, whereas *G. bulgarica* up to Bed No. 80. The latter does not occur in the two, uppermost thin beds (No. 81 and 82) of the section, therefore Kovács (1991 and in Márton *et al.* 1997) distinguished this part as G. bifurcata Zone and assigned it already to the Illyrian, according to previously published data (Budurov & Sudar 1991 and references therein). However, data from the Southern Alps by Nicora and Balini (in Kovács *et al.* 1990) and by Germani (2000) clearly document, that the LAD of *Gondolella bulgarica* and the FAD of *Paraceratites* gr. *trinodosus* slightly overlap in the Stabol Fresco section.

Nicora and Balini (in Kovács *et al.* 1990, p. 185) reported from Bed No. SF 92 *"Ceratites" abichi* and *Paraceratites* cf. *trinodosus,* and from Bed No. SF 96 still *G. bifurcata,* together with transitional forms between *G. bulgarica* and *G. hanbulogi*, as well as between *G. bifurcata* and *G. constricta cornuta*. On the other hand, on pl. 1 of the same paper *G. bifurcata*, *G. bulgarica* and transitional form between *G. bifurcata* and *G. constricta cornuta* were figured from Bed No. SF 96.

Germani (2000, p. 16 and pp. 55–57) reported the following first, respectively last occurences in the Stabol Fresco section:

SF 92 (= SF 85A):	FAD of *P.* gr. *trinodosus*
	LAD of *G. bulgarica* and *G. hanbulogi*
SF 93:	FAD of *G. constricta cornuta*
SF 96:	LAD of *G. bifurcata*

In the interval from Bed SF 93 to SF 96 *G. bifurcata*, *G. praeszaboi* (not present in the Balaton Highland) and *G. constricta cornuta* overlap. This narrow overlapping zone at the basal part of the Trinodosus Zone is well documented in other sections in the Southern Alps, as well: Sotto le Rive (Farabegoli & Perri 1998a), Nosgieda (Farabegoli & Perri 1998b) and Dont (Balini & Nicora 1998); without *G. bulgarica*, but already with ammonoids of the Trinodosus Zone in the former two. Our studied sections at the Balaton Highland do not reach this zone.

Conclusions

(1) The Balatonicus, Zoldianus and Binodosus Subzones (according to Vörös 1998 and this volume), cannot be distinguished on the basis of the phylogenetically related gondolellids (*G. bulgarica, G. hanbulogi, G. bifurcata*) due to the evident facies control on their distribution.

(2) A lower, G. bulgarica and an upper, G. bifurcata Dominance Zone can be recognized in most of the studied areas in Europe: Balkanide Triassic of Bulgaria and Inner Dinarides of former Yugoslavia (Budurov 1975, 1980; Sudar 1982; Budurov & Sudar 1991), the Southern Alps in Italy (Farabegoli & Perri 1998a, b; Balini & Nicora 1998) and in Hungary (Kovács *et al.* 1989, Kovács 1991 and in Márton *et al.* 1997). However, as opposed to ammonoid zones, these can rather be used only for intra-regional and not for Tethyan correlations between the middle part of the Osmani Zone and upper boundary of Binodosus Subzone.

(3) *Neospathodus kockeli* and *N. germanicus*, which appear to be good stratigraphic markers within the Germanic Basin (KOZUR 1972, 1980) are rare in most of the above mentioned areas. Moreover, they are related to a quite different evolutionary lineage, they occur together throughout the studied sections herein, therefore cannot be used for precise stratigraphic correlation within the relevant time interval.

(4) Based on the ammonoid and conodont data from the Aszófő and Felsőörs sections at the Balaton Highland and from the Stabol Fresco section in the Southern Alps, the re-integration of the Binodosus Subzone (or Binodosus Zone s.s.) into the Pelsonian Substage (which was originally defined by this ammonoid) seems reasonable and well supported.

(5) The most significant conodont evolutionary event in the Anisian that is marked by the disappearence of the *G. bulgarica, G. hanbulogi* and *G. bifurcata* association and with the appearence of the *G. constricta* group (= *Neogondolella* for some workers), associated with a distinctly different gondolelloid association, can be recognized at the basal part of the Trinodosus Zone (the IVth ammonoid horizon of ASSERETO, 1971). It supports the definition of the Pelsonian and Illyrian substages by the FAD of *Paraceratites trinodosus* group and of the *Gondolella constricta* group (*e.g.* of *G. constricta cornuta*). At present, the Stabol Fresco section appers to be the best candidate for the boundary stratotype of the Pelsonian and Illyrian Substages.

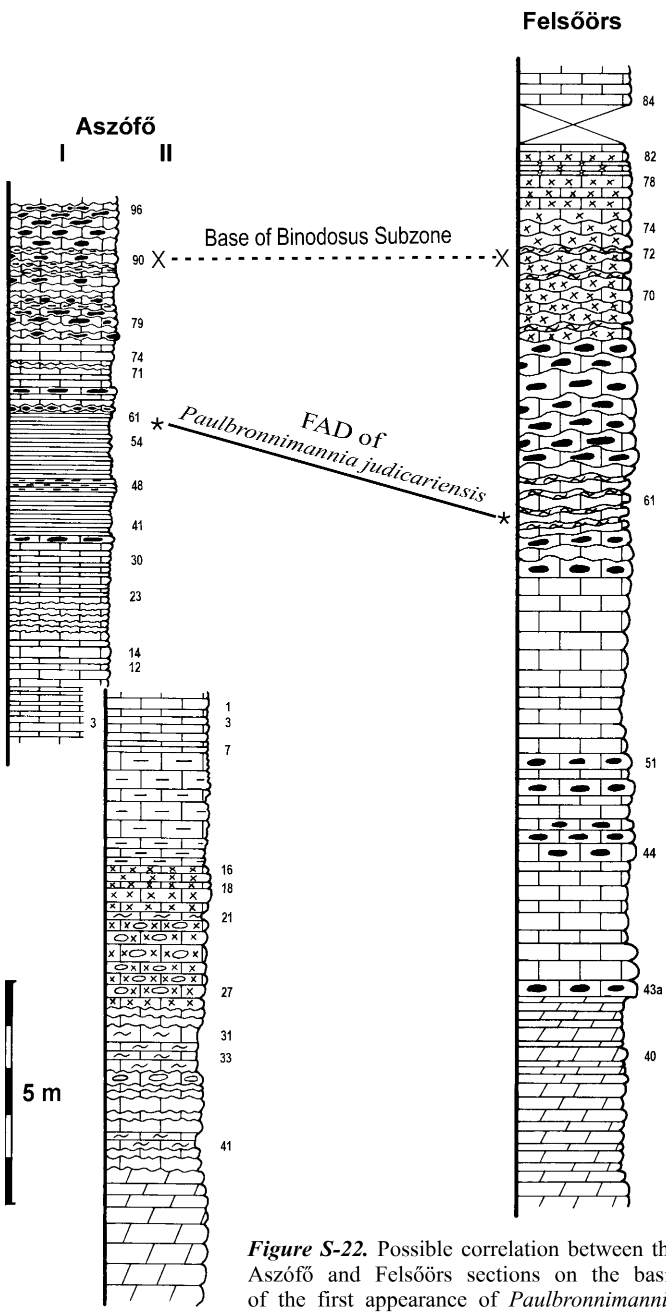

Figure S-22. Possible correlation between the Aszófő and Felsőörs sections on the basis of the first appearance of *Paulbronnimannia judicariensis*
For legend see Figure S-3

FORAMINIFER BIOSTRATIGRAPHY

(compiled by ATTILA VÖRÖS with the contribution ANNA ORAVECZ-SCHEFFER)

The abundant and diverse Pelsonian foraminifer fauna was studied in thin sections by A. Oravecz-Scheffer; she described and illustrated the assemblages from the Felsőörs Formation (in SZABÓ *et al.* 1980) and the Tagyon Formation (ORAVECZNÉ SCHEFFER 1980). The results are summarised in the profusely illustrated monograph on the Triassic foraminifers of the Transdanubian Range (ORAVECZ-SCHEFFER 1987).

The recognised Pelsonian foraminifer taxa are listed according to the localities (Aszófő, Felsőörs, Szentantalfa, Dörgicse, Balatonfüred) in the respective parts of this chapter.

The foraminifer assemblages of the Tagyon Formation (shallow water carbonate platform) and the Felsőörs Formation (deeper marine, basin facies) are almost totally different in taxonomical composition, therefore a direct biostratigraphical correlation between them is not possible. Nevertheless, the Pelsonian age of the two formations can be proved independently.

The lowermost samples of the Tagyon Limestone in the borehole Szentantalfa (Szaf–1) contains "*Diplotremina astrofimbriata* KRISTAN-TOLLMANN" and this species occurs upward in the cores throughout the formation. This is taken as a positive evidence for the Anisian age of the Tagyon Formation (ORAVECZNÉ SCHEFFER 1980, ORAVECZ-SCHEFFER 1987).

From the rich foraminifer association of the Felsőörs Formation, *Paulbronnimannia judicariensis* (PREMOLI SILVA) was highlighted by ORAVECZ-SCHEFFER (1987) as a Pelsonian guide fossil. It occurs in the Felsőörs and Aszófő sections and in the borehole Balatonfüred (Bfü–1). Its first appearance in Bed 57 in the Aszófő section (ORAVECZ-

SCHEFFER, pers. comm.) nearly coincides with the base of the Zoldianus Subzone (Bed 59). The first appearance of *Paulbronnimannia judicariensis* was recorded in Bed 59 of the Felsőörs section (SZABÓ *et al.* 1980). It is very remarkable that this level is five metres below the base of the Binodosus Subzone and may correspond to the Zoldianus Subzone (not yet proved in the Felsőörs section). This may give an independent tool for correlation between the two important Pelsonian sections Aszófő and Felsőörs (Figure S-22).

DASYCLADACEAN BIOSTRATIGRAPHY

(OLGA PIROS)

Triassic platform carbonates are widely extended in the Transdanubian Range. The platform limestones (and dolomites) of predominantly lagoonal facies, sporadically contain dasycladaceans in rock-forming quantities. Two lithostratigraphic units of platform carbonate facies belong to the Anisian on the Balaton Highland: the Megyehegy Dolomite Formation and the Tagyon Limestone Formation.

The **Megyehegy Dolomite Formation** locally contains crinoid and dasycladacean fragments [*e.g.* in the surroundings of Tótvázsony (BUDAI & CSILLAG 1998)]. On the basis of the Dasycladacean species (*Physoporella pauciforata* var. *pauciforata* PIA ex BYSTRICKÝ 1964, *Physoporella pauciforata* var. *undulata* PIA 1935, *Oligoporella* sp.) the age of the formation is Anisian. Because these species are common from the bottom to top of the Anisian beds there is no possibility to classify the Megyehegy Dolomite into any defined Dasycladacean assemblage zones.

The **Tagyon Formation** is made up by the alternation of light grey bedded limestone and of yellow to beige, laminated (stromatolitic) limestone with birdseye structures. In the borehole Dörgicse–1 (Drt–1) the bedded dasycladacean and the yellow stromatolitic limestones alternate rhythmically, forming peritidal-lagoonal cycles akin to the Lofer cycles (BUDAI 1992). The dolomite in the quarry near the military airport of Szentkirályszabadja (also part of the Tagyon Formation) contains large oncoids and intraclasts (BUDAI *et al.* 1993), which alternate rhythmically with thinner stromatolitic laminated horizons. In the sections of boreholes Szentantalfa–1 (Szaf–1), Dörgicse–1 (Drt–1) and the quarry near the airport of Szentkirályszabadja the most frequent fossils are dasycladaceans and foraminifers. The dasycladaceans are: *Poncetella hexaster* (PIA 1912) GÜVENÇ 1979, *Physoporella pauciforata* var. *pauciforata* PIA ex BYSTRICKÝ 1964, *Physoporella pauciforata* var. *undulata* PIA 1935, *Physoporella pauciforata* var. *sulcata* BYSTRICKÝ 1962, *Physoporella pauciforata* var. *gemerica* BYSTRICKÝ 1962, *Physoporella varicans* PIA 1935, *Physoporella minutuloidea* HERAK 1967, *Teutloporella peniculiformis* OTT in GRANIER et DELOFFRE 1995, non 1963. Based on dasycladacean investigations 4 assemblage zones could be distinguished in the Anisian. (PIROS 2002). In the Tagyon Formation only **aI** and **aII** assemblage zones can be found (Table S-3).

Assemblage zone **aI** (Poncetella hexaster – Physoporella pauciforata pauciforata Zone). The main species is *Poncetella (Diplopora) hexaster* (PIA 1912) GÜVENÇ 1979. Well-preserved specimens of *Poncetella hexaster* occur only in this zone. Due to small diameter of its central stem and thick-walled undivided skeleton, *P. hexaster* does not belong to the most fragile alga species. It could survive in an environment of rather strong water agitation *e.g.* in the zone where oncoids and grapestones were formed. In this zone *Physoporella pauciforata* var. *pauciforata* PIA ex BYSTRICKÝ was also encountered.

Table S-3. Anisian Dasycladacean zones (after PIROS 2002)

Stage	Substage	Dasycladacean Zones PIROS (2002)	
ANISIAN	ILLYRIAN	a IV	*Diplopora annulatissima*
	ILLYRIAN / PELSONIAN	a III	*Diplopora annulatissima* *T. peniculiformis*, *Ph. dissita* *Ph. varicans*, *O. pilosa*
	PELSONIAN	a II	*T. peniculiformis* *O. pilosa*
	PELSONIAN	a I	*Ph. pauciforata*, *O. pilosa*, *Poncetella hexaster*

Assemblage zone **aII** (*Teutloporella peniculiformis*, *Physoporella pauciforata*, *Oligoporella pilosa*). The zone can be distinguished on the basis of the first occurrence (FO) of *Teutloporella peniculiformis*. The predominance of *Physoporella pauciforata* is also characteristic of this zone. In addition to this species *Physoporella pauciforata* var. *undulata*, var. *sulcata*, var. *gemerica*, *Physoporella varicans* and *Anisoporella anisica* are also common. The alga specimens are well-preserved. Branches and whorls of oblique sections are also distinctly visible. The alga sections are common and in some beds of lagoonal facies they occur in rock-forming quantity.

Based on these zones, the age of the Tagyon Formation in the Transdanubian Range is Pelsonian. On the basis of Dasycladacean zones the Tagyon Formation can be correlated with the Steinalm Limestone, but the deposition of the Tagyon Formation finished at the end of the Pelsonian.

MAGNETOSTRATIGRAPHY
(compiled by ATTILA VÖRÖS)

Sampling for magnetostratigraphic investigations was carried out by E. Márton and her team in the Aszófő and the Felsőörs sections. The samples from Aszófő did not provide conclusive result.

Magnetostratigraphy of the Felsőörs section was summarised and discussed by MÁRTON *et al.* (1997). The lower part of the section, including the Pelsonian strata, was sampled in 1981–1982. The short description of the methods, demagnetisation curves and VGP latitude data were given in the above paper.

The uppermost part of the Megyehegy Dolomite and the overlying beds of the dolomitised "transitional unit" (up to Bed 34) provided frequently opposing VGPs, *i.e.* many short reversal events. This part is here considered to be older than Pelsonian. No data were obtained from Beds 35 to 42.

Figure S-23 shows the Pelsonian portion of the Felsőörs section with the magnetic polarity column redrawn after MÁRTON *et al.* (1997). It starts with a rather long interval of reversed polarity (Beds 43 to 58), followed by a shorter normal polarity interval (Beds 59 to 65). The conclusive and continuous data set ends with a short reversed and another normal polarity interval (Beds 66 to 68, and 69 to 71, respectively). Further six samples from the top of the Pelsonian (Binodosus Subzone, Beds 75 to 81) yielded "ambiguous" or "transitional" VGPs, *i.e.* the palaeolatitudes were near-equatorial. It is important to note that, according to the palaeoecological and facies analysis, reworking (redeposition and/or bioturbation) played a significant role in the deposition of these calcarenitic beds.

The biostratigraphical correlation of the Pelsonian part of the Felsőörs section with the Aszófő section is rather ambiguous. Still, one may tentatively conclude that the major part of the Pelsonian (~ Balatonicus and Cadoricus Subzones) can be characterised by a long reversed polarity interval. The Zoldianus Subzone may correspond to a predominantly normal polarity interval, whereas the Binodosus Subzone (which is definitely proved biostratigraphically) provided ambiguous palaeomagnetic directions. The long Pelsonian reversed polarity interval found in Felsőörs seems to fit rather well into the composite polarity sequence of MUTTONI *et al.* (1998) except the long normal interval they put at the lowermost part of the Pelsonian. However, it should be borne in mind that the biostratigraphical correlation (between the Balaton Highland sections and the Nderlysaj and Kçira sections in Albania) is far from being reliable.

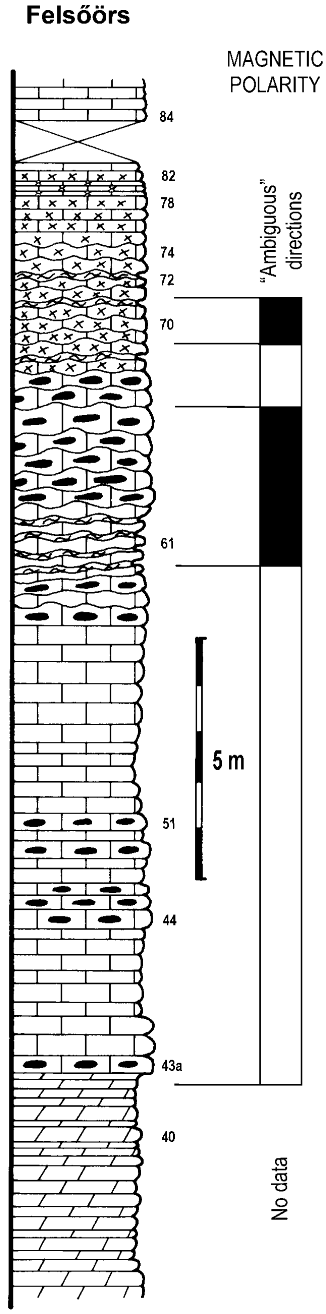

Figure S-23. Magnetic polarity column of the Pelsonian part of the Felsőörs section (drawing based on MÁRTON *et al.* 1997)
For legend see Figure S-3

SEQUENCE STRATIGRAPHY
(TAMÁS BUDAI)

Pelsonian age is generally considered as one of the main transgressive periods during the Triassic history of the Transdanubian Range (BUDAI & HAAS 1997, HAAS & BUDAI 1999). It is worth emphasizing that in the area of the Balaton Highland the relative change in the sea level was predominantly determined by extensional tectonic movements during the Middle Anisian (BUDAI & VÖRÖS 1992, 1993). As a consequence of the disintegration of the Early Anisian carbonate ramp at the turn of the Bithynian/Pelsonian basins were formed on the subsided blocks while isolated carbonate platforms evolved on the uplifted ones. Tectonically controlled platform-basin boundary could have been reconstructed near Aszófő by the abrupt lateral change of coeval platform and basin facies and by the occurrence of redeposited slope sediments (BUDAI & HAAS 1997, VÖRÖS *et al.* 1997). Extensional conditions are attributed to strike-slip movements in the Southern Alps (DOGLIONI 1987, GIANOLLA *et al.* 1998, GAETANI *et al.* 1998). It is plausible that mainly this type of tectonics controlled the basin evolution of the western end of the Tethys shelf during the Middle Anisian. However, eustatic sea-level rise may have also been contributed to the relative rise of the sea level in the Pelsonian. It is also reflected in the appearance of Tethyan faunal elements in the Germanic Basin (HAGDORN 1991, VÖRÖS 1992) in connection with a maximum flooding interval (AIGNER & BACHMANN 1992).

INTEGRATED STRATIGRAPHY

(Attila Vörös)

The Pelsonian Substage of the Balaton Highland comprises basinal successions (Felsőörs Formation) and coeval carbonate platforms (Tagyon Formation).

The age of the carbonate platforms was dated by their foraminifer and dasycladacean associations, and by a single find of *Balatonites balatonicus* (at Szentkirályszabadja), as Pelsonian. The two local carbonate platforms (the Dörgicse platform, represented by the boreholes Szentantalfa–1 and Dörgicse–1, and the Szentkirályszabadja platform, exposed in the quarry at the military airport of Szentkirályszabadja, respectively) have been correlated by dasycladacean stratigraphy: both platforms belong to the Assemblage Zones **aI** and **aII** of Piros (2002). Neither the foraminifer, nor the dasycladacean associations provide possibility for precise intercalibration between the platform and basinal successions.

The basinal successions, on the other hand, have been successfully correlated, first of all by their successive ammonoid associations. The four important surface sections (Köveskál, Mencshely, Aszófő and Felsőörs) have been subdivided into ammonoid Subzones (Balatonicus, Cadoricus, Zoldianus and Binodosus) which were traceable consistently along the Balaton Highland (see Figure S-16) and even in the Alpine region (Figure S-17). Multiple stratigraphic investigations have been restricted to the Aszófő and Felsőörs sections offering an opportunity to correlate these two sections more precisely and develop their integrated stratigraphy.

The biostratigraphy of the Aszófő section is fair enough: the ammonoid and conodont record is detailed and comprehensive; important foraminifer data are also available. Unluckily, the section did not provide conclusive palaeomagnetic data. In the Felsőörs section, the ammonoids are restricted to the uppermost part; the conodont and foraminifer stratigraphy is well developed and there is a reliable palaeomagnetic data set.

The major problem in the correlation of the two important sections lies in the absence of ammonoid record in the lower (greater) part of the Felsőörs section; only the Binodosus Subzone can be proved in both sections. Moreover, the conodont studies resulted in a rather vague subdivision, because the boundary of the lower, G. bulgarica and the upper, G. bifurcata Dominance Zones is apparently blurred and influenced by environmental factors ("facies control": Kovács, this chapter).

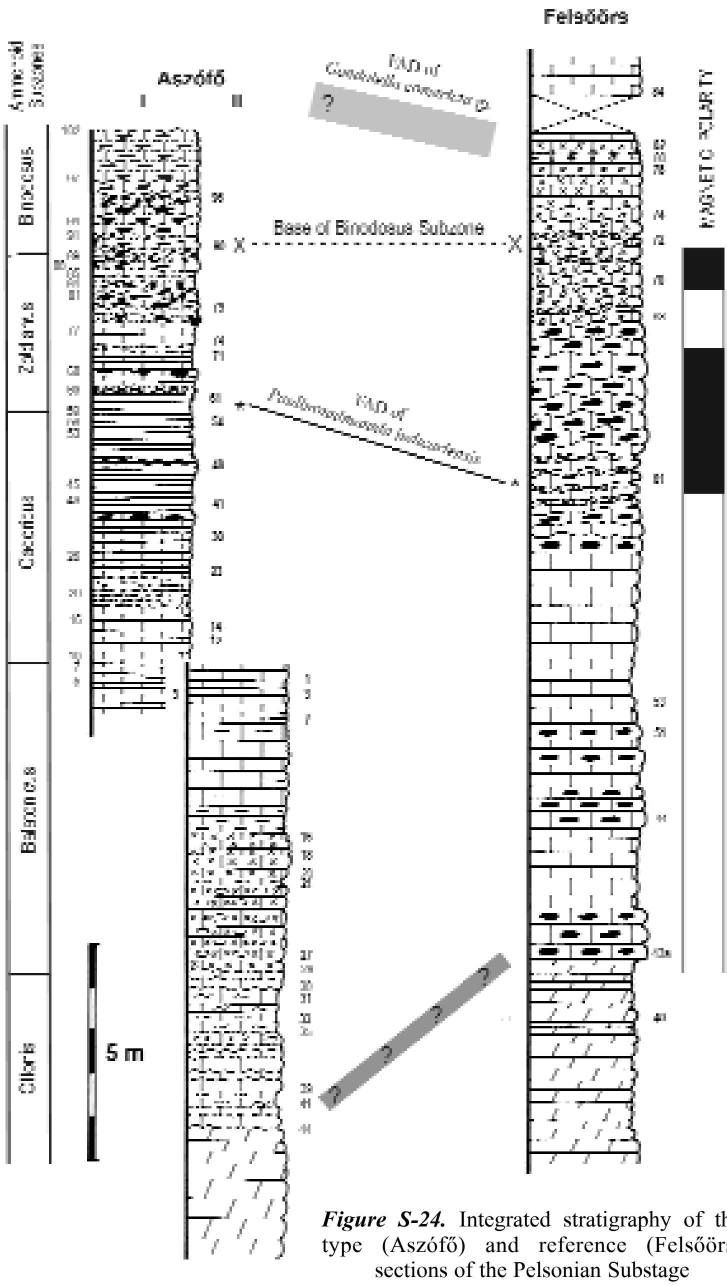

Figure S-24. Integrated stratigraphy of the type (Aszófő) and reference (Felsőörs) sections of the Pelsonian Substage

For legend see Figure S-3

After all, the reliable point of the correlation is the record of the Binodosus Subzone, the upper limit of which is also proved by the FAD of the *Gondolella constricta* group (Figure S-24). A little lower, the FAD of the guide foraminifer *Paulbronnimannia judicariensis* offers a useful correlation horizon between the Beds I/57 of the Aszófő and 59 of the Felsőörs sections. The lower conodont correlation horizon between Beds 41 of Aszófő II and 53 of Felsőörs (suggested by Kovács, this chapter) is admittedly vague and not acceptable for the present author. Instead, the first appearance of conodonts (in Beds No. II/41 of Aszófő and 43a of Felsőörs, respectively) is preferred here as an "ecostratigraphic" datum. The intervening part of the Felsőörs section (barren of ammonoids) may tentatively be subdivided and correlated with the respective ammonoid subzones of the Aszófő section, if a similar and more or less steady rate of sedimentation is supposed.

With a very tentative extrapolation of the ammonoid subzones, established in Aszófő, to the Felsőörs section, the magnetostratigraphic reversals recorded in Felsőörs may be intercalibrated with the ammonoid subzones as follows. The Ottonis, Balatonicus and Cadoricus Subzones, and consequently the base of the Pelsonian Substage, fall into a longer, reverse polarity interval. The Zoldianus Subzone corresponds to a dominantly normal polarity interval whereas the Binodosus Subzone did not provide consistent VGP directions.

THE STRATOTYPE OF THE PELSONIAN SUBSTAGE

(ATTILA VÖRÖS)

According to the rules of the International Commission on Stratigraphy the substages are formal units of the stratigraphical nomenclature, therefore their definition may follow the same rules as those of stages. However, the Triassic System is, as yet, short in "golden spikes" (GSSPs); even the stage boundaries are needed to be defined and/or ratified. Therefore the selection of a Triassic substage GSSP seems to be untimely. Nevertheless, a scientific definition of a substage, in this case the Pelsonian, may involve at least an informal selection of a "stratotype".

MOJSISOVICS, WAAGEN & DIENER (1895, p. 179, in table) regarded the Balaton region as the type area of the substage "Balatonisch". PIA (1930, figs 2, 3), when introducing the substage name "Pelson" indicated the Dont valley as type section. From this time onwards, the Pelsonian Substage name has been widely used for the middle part of the Anisian but without properly defined stratigraphical and palaeontological content.

In his revealing work ASSERETO (1971) threw new light on several open problems and contradictions of the Middle Triassic stratigraphy, but did not touch the subdivision of the Anisian (*i.e.* the Pelsonian). The same holds true for the paper by SUMMESBERGER & WAGNER (1972) giving important information by the description of the classical Grossreifling section, the proposed stratotype of the Anisian.

When introducing two new Anisian Substages (Aegean and Bithynian), ASSERETO (1974) dealt also with the Pelsonian Substage and suggested that the upper boundary should be drawn at the appearance of *"Paraceratites binodosus"*. At the same time — since the ammonoid record was not continuous even in the candidate Grossreifling section — he left open the question of the lower boundary of the Pelsonian.

KOZUR (1974) published a detailed faunistical documentation of the Germanic Middle Triassic and discussed its possible correlation with the Tethyan stratigraphic units. According to him the Germanic "Myophoria vulgaris–Beneckeia buchi–Dadocrinus assemblage zone", containing (among others) the ammonoid species *Acrochordiceras damesi, Noetlingites strombecki* and *Balatonites ottonis*, belongs to the Lower Anisian ("Hydasp") Substage, whereas the subsequent "Decurtata Zone", with *Balatonites* cf. *corvini, B. nobilis, Bulogites zoldianus, Paraceratites binodosus* and other ammonoid species, comprises the Pelsonian. KOZUR (1974, p. 16) suggested also that the oldest layers with *Balatonites* at Rahnbauerkogel and at the Balaton Highland should be taken as deepest Pelsonian.

In Hungary, DETRE (1974, 1975) called the attention to the unsolved problems in the Middle Triassic stratigraphy. SZABÓ *et al.* (1980) improved the knowledge on the Pelsonian Substage in the Felsőörs section with new micropalaeontological data. The first detailed Pelsonian ammonoid record of the Balaton Highland, based on bed-by-bed collection, was published by VÖRÖS (1987) who proposed a new subzonal scheme as well. Afterwards, the deeper part of the Aszófő section was also presented (VÖRÖS 1998), and by this, Aszófő became one of the most significant Pelsonian sections in the Alpine region.

As further progress, a comparative study of the Grossreifling sections and Aszófő was published (TATZREITER & VÖRÖS 1991). Later, TATZREITER (2001) reached to the conclusion that the deeper (Rahnbauerkogel) ammonoid horizon at Grossreifling belonged to the Bithynian Substage and, because there was a 80 m thick unexposed part between this and the overlying, Upper Pelsonian (Tiefengraben) ammonoid horizons, the Grossreifling section did not seem to be suitable for defining the base of the Pelsonian.

BALINI *et al.* (1993) proved that the well-exposed sections in the Giudicarie region with good ammonoid record (*e.g.* Stabol Fresco) comprise only the upper part of the Pelsonian Substage (Balatonicus Zone). More or less the same holds true for the classical Dont section (BALINI 1993, MUTTONI *et al.* 1998). MIETTO & MANFRIN (1995) indicate some South Alpine sections straddling the lower boundary of the Pelsonian Substage, however, the relevant detailed palaeontological and/or stratigraphical documentation of these sections is still awaited.

In contrast to the above mentioned localities, the sections of the Kocaeli Peninsula in Turkey (*e.g.* Gebze VI) provide splendid record of the Bitynian/Pelsonian boundary interval, but do not give palaeontological information on the higher part of the Pelsonian (ASSERETO 1974, FANTINI SESTINI 1988).

A very important fauna with *Balatonites ottonis* group and *Acrochordiceras* was found in the Angolo Limestone of Lombardy (Schilpario, Val dei Gatti) by BRACK *et al.* (1999) what was correlated with the upper Gogolin Beds of the Germanic facies area (Silesia). The higher part of the exposed sequence did not yield diagnostic fossils.

As it is seen from the above review and from Figure S-17, the Aszófő section is the only one among the well studied European sections, where all of the Pelsonian subzones and the underlying Ottonis Subzone can be recorded, in superimposed order in sequence. The conodont record is also good here. These facts render Aszófő to be the most suitable candidate for being the type section of the Pelsonian Substage. It is complemented with the important reference section at Felsőörs where magnetostratigraphy and even more detailed conodont record are available. Their geographic location, near the shores of the lake Balaton (Lacus Pelso, lending the name of the substage), supports this choice. **The proposed base of the Pelsonian Substage is at Bed II/28 of the Aszófő section, at the FAD of *Balatonites balatonicus*.**

The stratigraphical and palaeontological content of the Pelsonian Substage in its type area (Balaton Highland) is documented in the following respective chapters of this volume.

PELSONIAN BASIN EVOLUTION OF THE BALATON HIGHLAND

Tamás Budai & Attila Vörös

The Pelsonian age was one of the most dynamic time interval in the Triassic history of the Transdanubian Range. The whole sedimentary evolution of the TR can be subdivided into three depositional cycles and will shortly be summarised here (after Haas & Budai 1995 and Budai & Haas 1997).

The first cycle lasted from the Permian/Triassic boundary till the end of the Early Triassic. The sedimentation during this more or less steady period was controlled mainly by climatic and eustatic sea-level changes. The significant transgression at the beginning of the Induan resulted in the formation of a wide ramp, characterized by mixed siliciclastic and carbonate sedimentation in shallow subtidal to peritidal environments. As a result of upfilling by terrigeneous clastics and climatic change, the Early Triassic basin was replaced by a broad and shallow carbonate ramp at the beginning of the early Anisian.

The second cycle, from the middle Anisian till the early Carnian, was much more dynamic, than the first one. The gradual evolution of the Balaton Highland was suddenly and drastically disturbed by the Pelsonian synsedimentary tectonic event. The shallow marine carbonate ramp (Megyehegy Dolomite) was disrupted into large blocks along normal faults (Figure E-1, E-2). Relatively narrow ("halfgraben"-type), more or less restricted basins were formed in the subsided areas (*e.g.* „Felsőörs basin"). Isolated carbonate platforms were developed on the uplifted blocks in the middle part of the Balaton Highland ("Tagyon platform") and on the Veszprém Plateau ("Megyehegy platform"). From the tectonically controlled platform margins bio- and lithoclasts were transported along the slope into the basin (Felsőörs Formation, Horoghegy Member). Block rotations along listric faults and/or sea-level drop led to partial subaerial exposure and erosion on the platforms in the early Illyrian (*e.g.* at Szentkirályszabadja).

Contemporaneously with the onset of alkaline acidic volcanism starting in the late Anisian (tuff layers in the Vászoly Formation), a uniform basin developed in the entire region of the Balaton Highland (Buchenstein Formation). During the late Ladinian to early Carnian highstand period, the carbonate platforms (Budaörs Dolomite) prograded from N and NE towards the "Füred basin" of the Balaton Highland.

During the third cycle new carbonate platforms developed (Sédvölgy and Ederics Formations) being isolated from each other by intrashelf basins that received increasing siliciclastic sediment input (Veszprém Formation). By the late Carnian the basins were filled up (Sándorhegy Formation) and platforms prograded over the levelled topography and formed a huge platform-system (Main Dolomite).

The Pelsonian was a time of some key events in the geological history of the Balaton Highland (Budai & Vörös 1992, Vörös *et al.* 1997). The synsedimentary tectonic movements, which started in the Pelsonian, manifest the rifting process of the Neotethys ocean branch. As a result of the block faulting, diverse sedimentary environments were formed and different sediments have been deposited in the Balaton Highland area (Figure E-1).

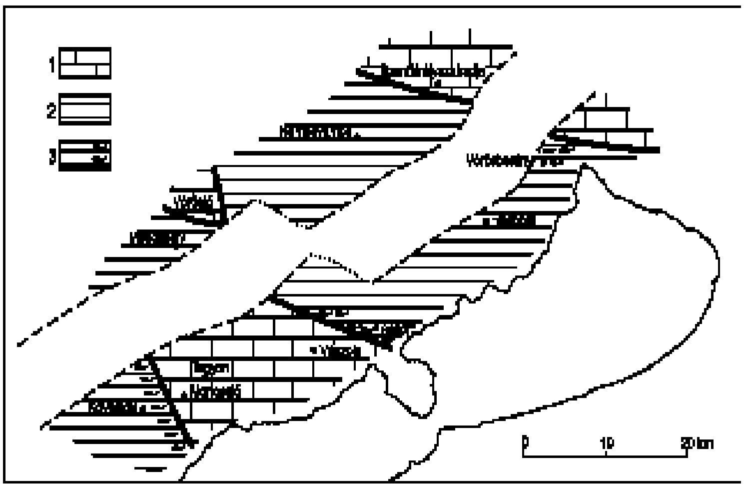

Figure E-1. Facies map of the Balaton Highland in the time of the Balatonicus Subzone (after Vörös *et al.* 1997)

Legend: 1 — platform carbonates; 2 — limestones of basin facies; 3 — "Recoaro"-type limestone

During most of the Pelsonian, shallow marine limestones characterised by cyclic alternation of peritidal and subtidal facies were formed in the northeastern (Szentkirályszabadja) and in the central (Tagyon, Dörgicse) part of the Balaton Highland. From time to time, these platform carbonates became subaerially exposed, as indicated by signs of vadose diagenesis and caliches. In the intervening areas (*e.g.* Felsőörs, Aszófő, Mencshely, Köveskál), deeper marine, well-bedded, siliceous or bituminous, nodular or laminated limestones were formed coevally (Felsőörs Formation).

This facies distribution is interpreted in terms of a dissected submarine topography (Figure E-2). In the first step of the evolution, the formerly more or less uniform carbonate ramp of the Megyehegy Dolomite was disrupted by normal faults. The northeastern and central regions kept their elevated, shallow marine position and grew as isolated carbonate platforms. Regular, partly biomicritic, argillaceous mudstone sediments accumulated in rather uniform thickness in the intervening basins.

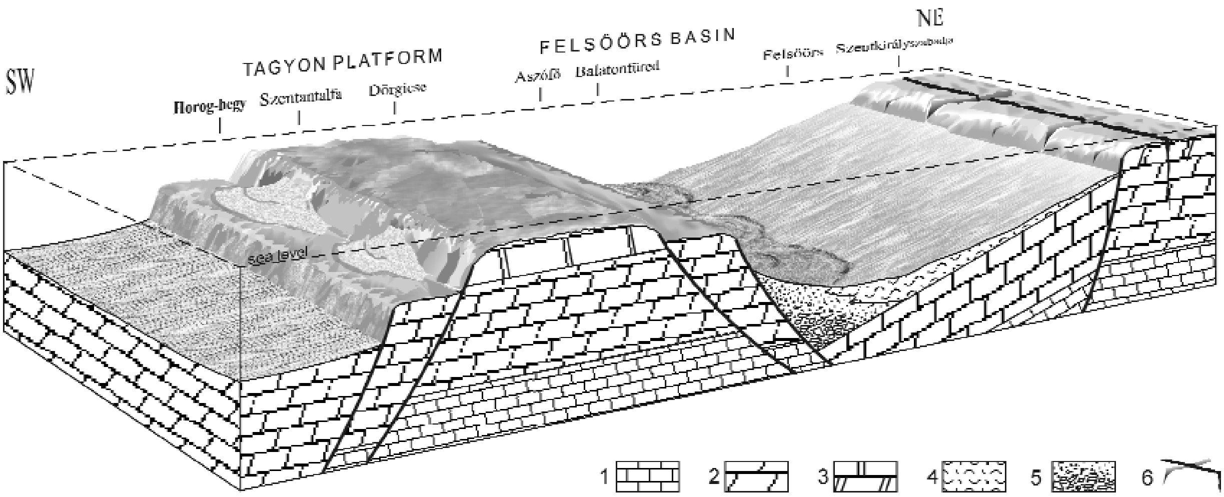

Figure E-2. Model of Pelsonian sedimentary environments of the Balaton Highland
Legend: 1 — Iszkahegy Limestone; 2 — Megyehegy Dolomite; 3 — Tagyon Formation (limestone/dolomite); 4–5 — Felsőörs Formation (4 — basin facies; 5 — slope facies); 6 — neptunian dyke

The first sedimentary manifestation of the activity of normal faults appeared in the form of intraclastic mudstone intercalations in the Felsőörs Formations, near the base of the Balatonicus Subzone, *i.e.* the base of the Pelsonian (*e.g.* at Köveskál and Aszófő). The intraclasts are interpreted as disintegrated semiconsolidated sediments redeposited along submarine slopes. Steeper submarine slopes with partly lithified surface developed afterwards, and provided ample opportunity for settlements of sessile benthic organisms (crinoids, brachiopods, *etc.*). The produced biodetritus was carried downslope and accumulated at the toe of the slope ("Recoaro"-type limestones, Horoghegy Member). In some cases these toe of slope sediments were affected by gravity sliding and slump-folding (*e.g.* in the Aszófő II section). Rarely, these biodetrital limestones also contain platform-derived grains (dasycladacean fragments, thick-shelled molluscs) suggesting the simultaneous existence of carbonate platforms.

The areal distribution of the biodetrital limestones is apparently connected to the fault zones bordering the shallow carbonate platforms (Figure E-1). The first, major bioclast accumulation period was dated in the lower Pelsonian Balatonicus Subzone (Köveskál, Aszófő), whereas a second one was found in the uppermost Pelsonian, around the boundary of the Zoldianus and Binodosus Subzones (Köveskál, Felsőörs) (VÖRÖS & PÁLFY 2002).

All these suggest that the block-faulted tectonic pattern and the general features of the sedimentation of the Balaton Highland remained more or less constant through the Pelsonian. Growth of carbonate platforms kept pace with the slow subsidence of the area, and the repeated faulting did not modify the geometry of the basins. Rotational block movements and the demise of carbonate platforms commenced only in the Illyrian.

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Part II

Palaeontology and microfacies

THE PELSONIAN DASYCLADALES OF THE BALATON HIGHLAND

OLGA PIROS

INTRODUCTION

The platform carbonates in the Transdanubian Range, mainly of shallow lagoonal facies, sporadically contain Dasycladales in rock-forming quantities. K. Hofmann was the first author who mentioned dasycladaceans from the platform carbonates of the Transdanubian Range (HOFMANN 1871). KUTASSY (1926) also reported dasycladaceans from Triassic dolomites and he emphasized the statigraphic significance of these fossils. These publications referred to Dasycladaceans form the Middle and Upper Triassic dolomites.

Until the end of the 1980s, some authors noticed "algal laminites" or dasycladaceans in the Megyehegy Dolomite and Tagyon Limestone of the Balaton Highland (*e.g.* SZABÓ 1972, RAINCSÁK 1980, BALOGH 1981). A. ORAVECZ-SCHEFFER was the first to determine some dasycladacean species from these formations (ORAVECZ-SCHEFFER 1987, HAAS *et al.* 1988). In the course of geological mapping of the area (in the late 1980s), T. Budai and G. Csillag collected samples rich in well-preserved dasycladaceans from the Megyehegy Dolomite and Tagyon Limestone. The determination of the rich dasycladacean flora proved the Anisian age of these formations (BUDAI *et al.* 1993, PIROS 2002). The list of dasycladaceans was published (BUDAI *et al.* 1993), but without systematic descriptions. The present work gives the systematic descriptions of dasycladaceans from three important Pelsonian localities on the Balaton Highland (Figure D-1).

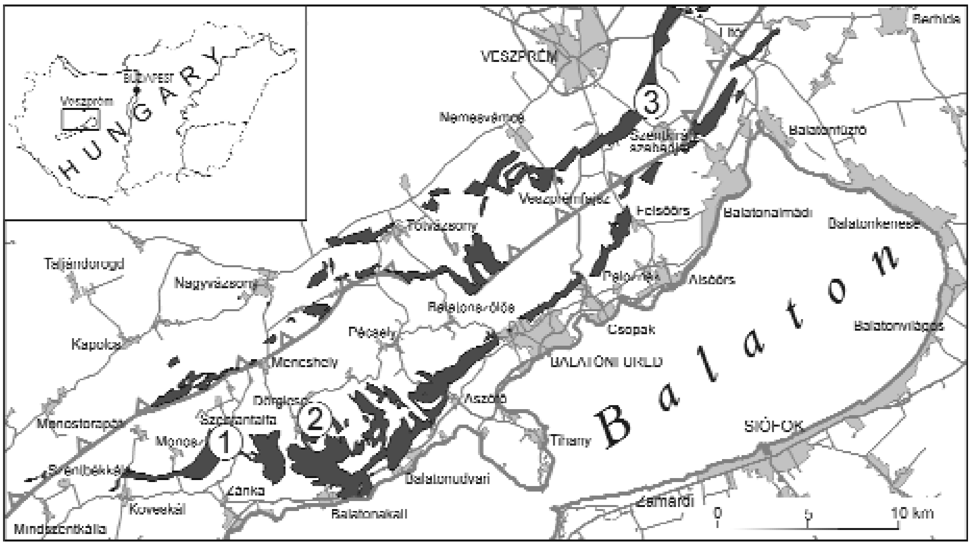

Figure D-1. Situation map showing the most important localities of the Balaton Highland providing Pelsonian dasycladaceans. The distribution of Pelsonian formations is shown dark shaded (barbed line marks the Litér overthrust)

1 — Szentantalfa Szaf–1 borehole; 2 — Dörgicse Drt–1 borehole; 3 — Szentkirályszabadja, airport quarry

SYSTEMATIC DESCRIPTIONS

In the following systematic descriptions the classification of BASSOULET *et al.* (1979) is used. The thin sections are deposited in the Geological Institute of Hungary.

The measurements (D = outer diameter, d = inner diameter, H = thickness of the wall, h = distance between the whorls, p = width of the pores at the widest part) are given in millimetres.

Phylum: Chlorophycophyta PAPENFUSS, 1946
Classis: Chlorophyceae KÜTZING, 1843
Ordo: Dasycladales PASCHEER, 1931
Family: Dasycladaceae [KÜTZING, 1843], STIZENBERGER, 1860
Tribe: Poncetelleae GÜVENÇ, 1979

Genus: **Poncetella** GÜVENÇ, 1979

***Poncetella hexaster* (PIA, 1912) GÜVENÇ, 1979 (*Diplopora hexaster* PIA, 1912)**

(Plate D-I, 1, 2, 3)

1912 *Kantia hexaster* n. sp. — PIA, Pl. VI(V), fig 13.
1920 *Diplopora hexaster* n. comb. — PIA, Pl. III, fig. 26–32.
1935 *Diplopora hexaster*— PIA, Pl. IV, fig. 1, 3.
1940 *Diplopora hexaster* — PIA, Pl. fig. 10.
1957 *Diplopora hexaster* — BYSTRICKÝ, Pl. VII, fig. 1-2.
1964 *Diplopora hexaster* — BYSTRICKÝ, Pl. XXII, fig 1.
1967 *Diplopora hexaster* — HURKA, Pl. 7, fig. 3.
1967 *Diplopora hexaster* — PANTIĆ, Pl. II, fig. 6–7.
1970 *Diplopora hexaster* — PANTIĆ, Pl. VI, fig. 1–3.
1970 *Diplopora hexaster*— PATRULIUS, Pl. I, fig. 5.
1979 *Poncetella hexaster* n. gen. n. comb — GÜVENÇ, p. 631., no illustration
1986 *Diplopora hexaster* — SUDAR, Pl. XXV, fig 3.
1993 *Diplopora hexaster* — SENOWBARI-DARYAN *et al.,* Pl. 56, fig. 12.
1994 *Poncetella hexaster* — BUCUR *et al.*, Pl. 13, fig. 4–5.
1994 *Poncetella hexaster* — FLÜGEL *et al.* Pl. 1, fig. 7–9.

Measurements:

Thin section	D in mm	d in mm	d/D in %	H in mm	h in mm	p in mm
1016 (cross)	1.80	0.50	27.77	0.75	-	0.10
1016	1.40	0.85	60.71	0.55	-	0.15

Description:

Thallus: Cylindrical, straight and thick wall with high calcification. Central stem is cylindrical, relatively thin. The inner surface of the central stem is smooth and straight. Whorled branches. Transversal sections are circular in shape.

Branches: Single whorled, metaspondyl, trichophorous type. Every branches laced in at the central part. Branches insert perpendicularly on the central stem.

Stratigraphic range: Pelsonian.

Occurrences: Hungary Ż Szentkirályszabadja (Sample 1016), Borehole Szentantalfa–1, Aggtelek Mountains; Slovakia (Slovenský Kras, Vysoké Tatry); Romania, Austria (Hochschwab), Serbia, Bosnia-Herzegovina, Slovenia, Italy.

Tribe: Salpingoporelleae BASSOULLET *et al.,* 1979
Sub-tribe: Salpingoporellinae BASSOULLET *et al.,* 1979

Genus **Physoporella** STEINMANN, 1903

***Physoporella pauciforata* var. *pauciforata* PIA ex BYSTRICKÝ, 1964**

(Plate D-II, 2, 3, 4; D-IV, 2)

1872 *Gyroporella pauciforata* n. sp. — GÜMBEL, Pl. D. III. fig. 2. a–f.
1912 *Physoporella pauciforata* emend. — PIA, Pl. V(IV), fig. 9–11.
1920 *Physoporella pauciforata* — PIA, Pl. III. fig. 10 & 15.
1927 *Physoporella pauciforata* — OGILVIE GORDON, Pl. IX, fig. 5.
1935 *Physoporella pauciforata* var. *simplex* n. var. — PIA, p. 223.
1957 *Physoporella pauciforata simplex* n. var. — BYSTRICKÝ, Pl. VI, fig. 1.
1958 *Physoporella pauciforata* — HERAK, Pl. 13, fig. 1–5.
1964 *Physoporella pauciforata* var. *pauciforata* n. var. — BYSTRICKÝ, Pl. XVIII, fig. 1.
1965 *Physoporella pauciforata* var. *pauciforata* — ASSERETO *et al.,* Pl. 80, fig. 1–3.
1965 *Physoporella pauciforata* — HERAK, Pl. IX, fig. 1.b.
1965 *Physoporella pauciforata* var. *simplex* — HERAK, Pl. XIII, fig. 5.
1966 *Physoporella pauciforata* var. *pauciforata* — MIŠÍK, Pl. II, fig. 1.
1967 *Physoporella pauciforata* var. *pauciforata* — BYSTRICKÝ, Pl. I, fig. 1.
1967a *Physoporella pauciforata* — HERAK, Pl. 8, fig. 5.
1967b *Physoporella pauciforata* var. *pauciforata* — HERAK, Pl. 1, fig. 2.

1972 *Physoporella pauciforata* var. *pauciforata* — Bleahu *et al.*, Pl. I, fig. 1–3.
1973 *Physoporella pauciforata* var. *pauciforata* — Kotański & Čatalov, Pl. X, fig. 1–6.
1973 *Physoporella pauciforata* — Popa *et* Dragastan, Pl. IV, fig. 14–15, 16.
1974 *Physoporella pauciforata* var. *pauciforata* — Mello, Pl. I, fig. 3.
1975 *Physoporella pauciforata* — Dragastan & Grădinaru, Pl. IV, fig. 24.
1980 *Physoporella pauciforata* — Dragastan, Pl. IV, fig. 2.
1982 *Physoporella pauciforata* var. *pauciforata* — Casati *et al.,* Pl. 35, fig. 1.
1986 *Physoporella pauciforata* var. *pauciforata* — Bystrický, Pl. II, fig. 2.
1986 *Physoporella pauciforata* — Kotański, Pl. CVI, fig. 9.b.
1988 *Physoporella pauciforata* var. *pauciforata* — Čanović & Kemenci, Pl. IV, fig. 1.
1989 *Physoporella pauciforata* var. *pauciforata* — Buček, Pl. II, fig. 1.
1989 *Physoporella pauciforata* — Gaetani & Gorza, Pl. 10, fig. 4.
1993 *Physoporella pauciforata pauciforata* — Budai, Lelkes & Piros, Pl. V, fig. 2.
1994 *Physoporella pauciforata* — Bucur *et al.*, Pl. 11, fig. 8–9.

Measurements:

Thin section	D in mm	d in mm	d/D in %	H in mm	h in mm	p in mm
1030 (transv.)	1.85	0.85	45.94	0.45	-	0.10
1030 (long.)	2.00	0.55	27.50	0.60	0.55	0.15
1030 (long.)	1.75	0.95	54.28	0.50	0.80	0.25
1030 (long.)	1.65	0.60	36.36	0.50	0.60	0.20
1019 (long.)	3.40	1.50	44.11	1.00	0.35	0.20
1019 (long.)	1.95	-	-	-	0.60	0.30
1019 (long.)	2.75	1.35	49.09	0.30	0.50	0.35
1019 (long.)	2.25	1.75	77.77	0.55	0.55	0.25
1019 (transv.)	2.25	1.50	66.66	0.40	-	0.20
1019 (long.)	3.50	1.40	40.00	0.60	0.15	0.25
1019 (long.)	2.55	1.50	58.82	0.55	0.25	0.25
1019 (transv.)	2.25	1.50	66.66	0.45	-	0.25
1023 (long.)	1.80	0.8	44.44	0.50	0.70	0.20
1023 (long.)	2.40	1.10	45.83	0.45	0.50	0.15
1023 (long.)	1.75	0.75	42.85	0.55	0.50	0.15
1023 (transv.)	2.50	1.25	50.00	0.60	-	0.20
1023 (transv.)	2.10	1.15	54.76	0.50	-	0.30
1023 (transv.)	1.95	1.00	51.28	0.50	-	0.20
1023 (transv.)	2.45	1.20	48.97	0.45	-	0.20
1020 (transv.)	2.50	1.00	40.00	0.65	-	0.15
1020 (transv.)	3.00	1.25	41.66	0.80	-	0.20
1020 (transv.)	2.00	1.00	50.00	0.65	-	0.15
1020 (transv.)	3.50	1.75	50.00	1.00	0.30	0.25
1020 (transv.)	2.00	0.85	42.50	0.45	-	0.20
1017 (transv.)	2.10	1.10	52.38	0.55	-	0.15
1017 (long.)	1.80	0.85	47.22	0.55	-	0.20
1017 (long.)	2.60	1.25	48.07	0.75	0.75	0.35
1017 (long.)	2.75	1.45	52.72	0.60	0.55	0.15
1017 (long.)	2.40	1.05	43.75	0.65	0.65	0.15
1017 (long.)	2.40	1.40	58.33	0.50	0.75	0.15
1017 (long.)	2.00	0.65	32.50	0.75	0.50	0.15
1017 (transv.)	2.00	1.00	50.00	0.45	-	0.15
1017 (long.)	2.00	0.75	37.50	0.60	0.50	0.15
1017 (long.)	1.40	-	-	-	0.75	-
1018 (long.)	2.05	1.35	65.85	0.50	0.60	0.25
1018 (long.)	2.35	1.30	55.32	0.50	0.60	0.15
1018 (long.)	1.60	0.75	46.87	0.45	0.40	0.20
1018 (transv.)	2.25	1.50	66.66	0.60	-	0.25
1018 (long.)	2.10	0.85	40.47	0.65	0.65	0.20
1016 (long.)	2.50	1.40	56.00	0.60	0.85	0.25
Upper part of ${}_{m}T^{2}$ (long.)	1.55	0.55	35.48	0.55	0.60	0.15
1031 (long.)	2.10	1.00	47.62	0.50	0.50	0.20
1031 (long.)	1.75	0.60	34.29	0.70	0.60	0.20
1031 (long.)	1.75	0.65	37.14	0.55	0.50	0.15
1014 (long.)	2.60	1.25	48.07	0.65	0.50	0.15
1013 (long.)	2.25	1.15	51.11	0.55	0.60	0.15
1010 (transv.)	2.10	1.15	54.76	0.60	-	0.15

Thin section	D in mm	d in mm	d/D in %	H in mm	h in mm	p in mm
1006 (long.)	2.50	1.35	54.00	0.60	0.65	0.25
1006 (long.)	2.15	1.15	53.49	0.45	0.75	0.25
1006 (long.)	1.75	0.50	28.57	0.75	0.60	0.25
1005 (transv.)	2.40	1.25	52.08	0.55	0.60	0.20
1005 (long.)	2.00	0.85	42.50	0.60	0.75	0.20
Dörgicse–1 93.90 m (long.)	2.50	0.90	36.00	0.55	0.75	0.25
Dörgicse–1 93.90 m (long.)	2.25	0.75	33.33	0.60	0.60	0.20
Dörgicse–1 93.90 m (long.)	2.60	1.10	42.31	0.80	0.90	0.30
Dörgicse–1 138.60 m (long.)	1.65	0.85	51.51	0.45	0.65	0.20
Dörgicse–1 138.60 m (long.)	1.75	0.75	42.86	0.60	0.60	0.25

Description:

Thallus: Cylindrical, straight and thick wall with high calcification. No annulation. Central stem cylindrical, relatively thick. The inner surface of the central stem is smooth and straight. Whorled branches. Transversal sections are circular in shape.

Branches: Single whorled, euspondyl, pyriferous type. The base of the branches large in diameter, the distal part is closed. Branches insert perpendicularly on the central stem.

Stratigraphic range: Pelsonian.

Occurrences: Hungary — Szentkirályszabadja (Samples 1005–1031), Borehole Szentantalfa–1, Borehole Dörgicse–1, Slovakia (Slovenský kras), Slovenia, Croatia, Greece, Austria (Hochschwab, Dachstein), Romania, Italy, Serbia, Bulgaria, Poland.

***Physoporella pauciforata* var. *undulata* PIA, 1935**

(Plate D-III, 1, 3, 4; D-IV, 2–4)

1920 *Physoporella pauciforata* var. ? *lotharingica* n. stat n. comb. — PIA, Pl. III, fig. 12, 14.
1935 *Physoporella pauciforata* var. *undulata* n. var. — PIA, fig. 33.
1935 *Physoporella pauciforata* var. *undulata* — OGILVIE GORDON, Pl. V, fig. 1.
1957 *Physoporella pauciforata undulata* — BYSTRICKÝ, Pl. VI, fig. 3.
1964 *Physoporella pauciforata* var. *undulata* — BYSTRICKÝ, Pl. XVII, fig. 3.
1964 *Physoporella pauciforata* var. *undulata* — DIENI & SPAGNULO, Pl. II, fig. 3–6.
1965 *Physoporella pauciforata* var. *undulata* — ZANIN BURI, Pl. 49, fig. 2b, 4, 5.
1967 *Physoporella pauciforata* var. *undulata* — BYSTRICKÝ, Pl. I, fig. 3–4.
1967 *Physoporella pauciforata* var. *undulata* — HERAK, Pl. 8, fig. 6.
1980 *Physoporella pauciforata* var. *undulata* — DRAGASTAN, Pl. III, fig. 7.
1983 *Physoporella pauciforata* var. *undulata* — BYSTRICKÝ, Pl. III, fig. 17, Pl. IV, fig. 20–22, Pl. V, fig. 23.
1986 *Physoporella pauciforata* var. *undulata* — BYSTRICKÝ, Pl. II. fig. 3.
1993 *Physoporella pauciforata undulata* — BUDAI, LELKES & PIROS, Pl. V. fig. 3.

Measurements:

Thin section	D in mm	d in mm	d/D in %	H in mm	h in mm	p in mm
1030 (long.)	1.55	0.55	35.48	0.45	0.60	0.10
1030 (long.)	1.70	0.75	44.12	0.55	0.35	0.20
1030 (transv.)	1.75	0.85	48.57	0.50	-	0.20
1030 (long.)	1.75	0.65	37.14	0.65	0.50	0.20
1023 (long.)	1.90	0.55	28.95	0.50	0.50	0.20
1023 (long.)	2.35	1.00	42.55	0.50	0.65	0.15
1023 (long.)	1.50	-	-	-	-	0.20
1020 (long.)	2.65	1.50	56.60	0.55	0.20	0.25
1020 (long.)	2.50	1.30	52.00	0.75	0.45	0.25
1017 (long.)	2.15	1.10	51.16	0.55	0.70	0.25
1017 (long.)	1.85	0.70	37.84	0.60	0.50	0.15
1017 (long.)	1.75	0.75	42.86	0.55	0.65	0.15
1017 (long.)	1.85	0.50	27.03	0.65	0.65	0.15
1017 (long.)	2.30	1.15	50.00	0.45	0.65	0.20

Thin section	D in mm	d in mm	d/D in %	H in mm	h in mm	p in mm
1018 (long.)	1.80	0.75	41.66	0.55	0.65	0.20
1018 (long.)	1.50	-	-	-	0.65	0.15
1014 (long.)	1.40	0.40	28.57	0.55	0.50	0.10
1014 (long.)	1.30	0.30	23.08	0.45	0.35	0.10
1006 (long.)	2.25	0.60	26.67	0.65	0.50	0.20
Dörgicse–1 93.90 m (long.)	2.00	0.70	35.00	0.65	0.55	0.15
Dörgicse–1 93.90 m (long.)	2.00	0.85	42.50	0.75	0.65	0.30
Dörgicse–1 93.90 m (long.)	1.65	0.50	30.30	0.60	0.50	0.20
Dörgicse–1 138.60 m (long.)	1.75	1.20	68.57	0.60	0.65	0.30

Description:

Thallus: Cylindrical, straight with high calcification and relatively thin wall. The external wall of the thallus is undulated. Central stem cylindrical, relatively thick. The internal surface of the central stem is smooth and straight. Whorled branches. In one segment only one whorl. Transversal sections are circular in shape.

Branches: Single whorled, euspondyl, pyriferous type. The base of the branches large in diameter, the distal part is closed. Branches insert perpendicularly on the central stem.

Stratigraphic range: Pelsonian.

Occurrences: Hungary — Szentkirályszabadja (Samples 1006–1030), Borehole Szentantalfa–1, Borehole Dörgicse–1; Slovakia (Slovensky kras), Slovenia, Croatia, Greece, Austria (Hochschwab, Dachstein), Romania, Italy, Serbia, Bulgaria, Poland.

***Physoporella pauciforata* var. *sulcata* Bystrický, 1962**

(Plate D-I, 4)

1962 *Physoporella pauciforata* var. *sulcata* n. var. — Bystrický, Pl. IV, fig. 2, 6.
1964 *Physoporella pauciforata* var. *sulcata* — Bystrický, Pl. XIV, fig. 1.
1964 *Physoporella pauciforata* var. *sulcata* — Dieni & Spagnulo, Pl. II, fig. 1–2.
1967b *Physoporella pauciforata* var. *sulcata* — Herak, Pl. 1, fig. 1, 3–5.
1970 *Physoporella pauciforata* var. *sulcata* — Pantić, Pl. X, fig. 1–4.
1972 *Physoporella pauciforata* var. *sulcata* — Bleahu *et al.,* Pl. I, fig. 4., Pl. II, fig. 1–3.
1973 *Physoporella pauciforata* — Popa & Dragastan, Pl. VIII, fig. 29, 30; Pl. XIV, fig. 53–54.
1975 *Physoporella pauciforata* var. *sulcata* — Dragastan & Grădinaru, Pl. III, fig. 19.
1982 *Physoporella pauciforata* var. *sulcata* — Casati *et al.,* Pl. 35, fig. 2.b, 7.
1986 *Physoporella pauciforata* var. *sulcata* — Bystrický, Pl. I, fig. 10.
1988b *Physoporella pauciforata* var. *sulcata* — Haas *et al.,* Pl. III, fig. 2.
1989 *Physoporella pauciforata* var. *sulcata* — Buček, Pl. II, fig. 3.
1993 *Physoporella pauciforata* var. *sulcata* — Budai, Lelkes & Piros, Pl. VI, fig. 3.

Measurements:

Thin section	D in mm	d in mm	d/D in %	H in mm	h in mm	p in mm
1017 (long.)	1.25	0.55	44.00	0.35	0.30	0.10
1018 (long.)	1.40	0.25	17.86	0.40	0.30	0.15
1018 (long.)	1.50	0.55	36.67	0.50	0.35	0.15

Description:

Thallus: Cylindrical, straight and relatively thin wall with high calcification. The external surface of the wall undulated. Central stem cylindrical, relatively thick. The internal surface of the central stem is smooth and straight. Whorled branches. Transversal sections are circular in shape.

Branches: Single whorled, euspondyl, pyriferous type. The base of the branches less large in diameter then var. undulata, the distal part is closed. The branches straight obliquely on the central stem.

Stratigraphic range: Pelsonian.

Occurrence: Hungary — Szentkirályszabadja (Samples 1017, 1018), Borehole Szentantalfa–1, Borehole Som–1; Slovakia (Slovenský kras), Austria (Hochschwab, Dachstein), Romania, Italy, Serbia, Bulgaria.

Physoporella pauciforata var. *gemerica* BYSTRICKÝ, 1962
(Plate D-III, fig. 2)

1962 *Physoporella pauciforata* var. *gemerica* n. var. — BYSTRICKÝ, Pl. IV, fig 4–5.
1964 *Physoporella pauciforata* var. *gemerica* — BYSTRICKÝ, Pl. XVI, fig. 1.
1964 *Physoporella pauciforata* var. *gemerica* — DIENI & SPAGNULO, Pl. II, fig. 4–5.
1966 *Physoporella pauciforata* var. *gemerica* — BYSTRICKÝ, Pl. VII, fig. 5.
1966 *Physoporella pauciforata* var. *gemerica* — MIŠÍK, Pl. II, fig. 1.
1967b *Physoporella pauciforata* var. *gemerica* — HERAK, Pl. I, fig. 7.
1982 *Physoporella pauciforata* var. *gemerica* — CASATI *et al.,* Pl. 35, fig 3, 9.
1986 *Physoporella pauciforata* var. *gemerica* — BYSTRICKÝ, Pl. II, fig. 1.
1989 *Physoporella pauciforata* var. *gemerica* — BUČEK, Pl. II, fig. 2.

Measurements:

Thin section	D in mm	d in mm	d/D in %	H in mm	h in mm	p in mm
1030 (long.)	1.90	0.60	31.58	0.65	0.70	0.35
1023 (long.)	2.25	1.15	51.11	0.50	0.40	0.30
1017 (long.)	2.00	0.85	42.50	0.65	0.50	0.35

Description:

Thallus: Cylindrical, straight and thin wall with high calcification. The external surface of the wall gently undulated. Central stem cylindrical, extremely thick. The inner surface of the central stem is smooth and straight. Whorled branches. Transversal sections are circular in shape.

Branches: Single whorled, euspondyl, pyriferous type. The base of the branches extremly wide, the distal part is closed. Branches insert perpendicularly on the central stem.

Stratigraphic range: Pelsonian.

Occurrences: Hungary — Szentkirályszabadja (Samples 1017–1030); Slovakia (Slovenský kras), Bosnia-Herzegovina, Austria (Dachstein), Romania, Italy.

Physoporella varicans PIA, 1935
(Plate D-III, 2)

1935 *Physoporella varicans* n. sp. — PIA, Fig. 43–44.
1957 *Physoporella varicans* — BYSTRICKÝ, Pl. VI, fig. 5.
1958 *Physoporella varicans* — HERAK, Pl. 13, fig. 6.
1964 *Physoporella varicans* — BYSTRICKÝ, Pl. XVIII, fig. 1.
1965 *Physoporella varicans* — ASSERETO *et al.*, Pl. 81, fig. 4–5.
1965 *Physoporella varicans* — HERAK, Pl. XII, fig. 1.
1988 *Physoporella varicans* — MASARYK, Pl. 1, fig. 1.

Measurements:

Thin section	D in mm	d in mm	d/D in %	H in mm	h in mm	p in mm
1030 (long.)	1.75	0.35	20.00	0.55	0.15	0.20
1030 (long.)	1.65	0.40	24.24	0.40	0.25	0.25

Description:

Thallus: Cylindrical, straight and moderately thin wall with high calcification. The external surface of the wall strongly undulated. Central stem cylindrical, relatively thick. The inner surface of the central stem is smooth and straight. Double whorled branches. Transversal sections are circular in shape.

Branches: Double whorled, euspondyl, pyriferous type. The base of the branches in the double whorl is common, the distal part is closed. The divergence of the branches is strong. Branches straight obliquely on the central stem. The angle between the branches and the central stem is 20–30°.

Stratigraphic range: Pelsonian.

Occurrence: Hungary — Szentkirályszabadja (Sample 1030); Slovakia (Slovenský kras), Bosnia-Herzegovina, Croatia, Italy, Romania.

Physoporella minutuloidea HERAK, 1967
(Plate D-III, 3; D-IV, 1)

1965 *Physoporella* cf. *minutula* — HERAK, Pl. XII, fig. 3.
1967a *Physoporella minutuloidea* n. sp. — HERAK, Pl. 9, fig. 1.

Measurements:

Thin section	D in mm	d in mm	d/D in %	H in mm	h in mm	p in mm
1030 (long.)	1.05	0.40	38.09	0.30	0.10	0.15

Description: The species is relatively small (smaller than *Physoporella dissita*).

Thallus: Cylindrical, straight with high calcification and thin wall. The external surface of the wall gently undulated. Central stem cylindrical, relatively thin. The internal surface of the central stem is smooth and straight. Whorled branches. Transversal sections are circular in shape.

Branches: Single whorled, euspondyl, pyriferous type. The base of the branches relatively thin, the distal part is closed. Branches insert nearly perpendicularly on the central stem.

Stratigraphic range: Pelsonian.

Occurrence: Hungary — Szentkirályszabadja (Sample 1030); Bosnia-Herzegovina, Croatia, Greece.

Genus: **Anisoporella** Botteron, 1961
***Anisoporella anisica* (Zanin Buri, 1965) Hurka, 1969**
(Plate D-III, 1)

1965 *Gyroporella anisica* n. sp. — Zanin Buri, Pl. 49, fig. 1–2a, 6a.
1969 *Anisoporella anisica* n. comb. — Hurka, p. 114, no illustration.
1972 *Anisoporella anisica* — Ott, Fig. 4, no. 1–3.

Measurements:

Thin section	D in mm	d in mm	d/D in %	H in mm	h in mm	p in mm
1019 (transv.)	1.75	1.20	68.57	0.20	-	0.10
1019 (transv.)	1.30	0.85	65.38	0.15	-	0.05

Description:

Thallus: Cylindrical, straight with high calcification and extremly thin wall. The external surface of the wall gently undulated. Central stem cylindrical, extremely thick. The internal surface of the central stem is smooth and straight. Double whorled branches. Transversal sections are circular in shape.

Branches: Double whorled, euspondyl, vesiculifer. The base of the branches in the double whorl is common, the distal part is closed. The base of the branches thin, the distal part is club-shaped. Branches straight gently obliquely on the central stem.

Stratigraphic range: Pelsonian.

Occurrence: Hungary — Szentkirályszabadja (Sample 1019), Austria (Tyrol), Italy.

Family: Seletonellaceae Korde, 1950
Tribe: Dasyporelleae Pia, 1920
Sub-tribe: Teutloporellinae Bassoulet *et al.,* 1979

Genus: **Teutloporella** [Pia 1912] Bassoulet *et al.,* 1978
***Teutloporella peniculiformis* Ott in Granier *et* Deloffre 1995, non 1963**
(Plate D-II, 1, 4; Plate D-III, 1)

1963 (nom. nud.) *Teutloporella peniculiformis* n. sp. — Ott, Fig 14, 20–24.
1966 (nom. nud.) *Teutloporella peniculiformis* — Ott, Fig. 3.
1971 (nom. nud.) *Teutloporella peniculiformis* — Zorn, Pl. 4, fig. 4.
1976 (nom. nud.) *Teutloporella peniculiformis* — Epting *et al.,* Fig. 6.
1980 (nom. nud.) *Teutloporella peniculiformis* — Dragastan, Pl. VII, fig 7.
1989 (nom. nud.) *Teutloporella peniculiformis* — Bučeк, Pl I, fig. 2.
1989 (nom. nud.) *Teutloporella peniculiformis* — Gaetani & Gorza, Pl 10, fig. 5.
1993 (nom. nud.) *Teutloporella peniculiformis* — Budai, Lelkes & Piros, Pl. VI, fig 1.
1994 (nom. nud.) *Teutloporella peniculiformis* — Bucur *et al.,* Pl. 10, fig. 8–9.
1995 (nom. nud.) *Teutloporella peniculiformis* — Ott in Granier & Deloffre, p. 57, no illustration.

Measurements:

Thin section	D in mm	d in mm	d/D in %	H in mm	h in mm	p in mm
1030 (long.)	1.55	0.55	35.48	0.45	0.60	0.10
1030 (long.)	1.70	0.75	44.12	0.55	0.35	0.20
1030 (transv.)	1.75	0.85	48.57	0.50	-	0.20
1030 (long.)	1.75	0.65	37.14	0.65	0.50	0.20
1023 (long.)	1.90	0.55	28.95	0.50	0.50	0.20
1023 (long.)	2.35	1.00	42.55	0.50	0.65	0.15

Thin section	D in mm	d in mm	d/D in %	H in mm	h in mm	p in mm
1023 (long.)	1.50	-	-	-	-	0.20
1020 (long.)	2.65	1.50	56.60	0.55	0.20	0.25
1020 (long.)	2.50	1.30	52.00	0.75	0.45	0.25
1017 (long.)	2.15	1.10	51.16	0.55	0.70	0.25
1017 (long.)	1.85	0.70	37.84	0.60	0.50	0.15
1017 (long.)	1.75	0.75	42.86	0.55	0.65	0.15
1017 (long.)	1.85	0.50	27.03	0.65	0.65	0.15
1017 (long.)	2.30	1.15	50.00	0.45	0.65	0.20
1018 (long.)	1.80	0.75	41.66	0.55	0.65	0.20
1018 (long.)	1.50	-	-	-	0.65	0.15
1014 (long.)	1.40	0.40	28.57	0.55	0.50	0.10
1014 (long.)	1.30	0.30	23.08	0.45	0.35	0.10
1006 (long.)	2.25	0.60	26.67	0.65	0.50	0.20
Dörgicse–1 93.90 m (long.)	2.00	0.70	35.00	0.65	0.55	0.15
Dörgicse–1 93.90 m (long.)	2.00	0.85	42.50	0.75	0.65	0.30
Dörgicse–1 93.90 m (long.)	1.65	0.50	30.30	0.60	0.50	0.20
Dörgicse–1 138.60 m (long.)	1.75	1.20	68.57	0.60	0.65	0.30

Description:

Thallus: The calcareous skeleton has an appearance of a "fox tail". Central stem is extremely thin. Some specimens exhibit a wider central stem on their upper part, because of the V-shaped uncalcified branches. The relatively thick wall is pierced by numerous circular and weakly recognizable pores. Transversal sections are circular or oval in shape. In transversal section the central stem can never be seen, only the transversal sections of the branches.

Branches: Single whorled, euspondyl, trichophorous type. The base of the branches is not wider than the distal part, the distal part is opened. The branches straight obliquely on the central stem.

Stratigraphic range: Pelsonian.

Occurrences: Hungary — Szentkirályszabadja (Samples 1014–1030), Borehole Dörgicse–1, Aggtelek Mountains; Slovakia (Slovenský kras), Italy, Romania, Austria (Tyrol).

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Plate D-I

1. *Poncetella hexaster* (PIA 1912) GÜVENÇ, 1979, Sample 1016 (Szentkirályszabadja), M: 13×.
2. *Poncetella hexaster* (PIA 1912) GÜVENÇ, 1979, Sample 1018 (Szentkirályszabadja), M: 13×.
3. *Poncetella hexaster* (PIA 1912) GÜVENÇ, 1979, Sample 1016 (Szentkirályszabadja), M: 13×.
4. *Physoporella pauciforata* var. *sulcata* BYSTRICKÝ, 1962, Sample 1018 (Szentkirályszabadja), M: 13×.

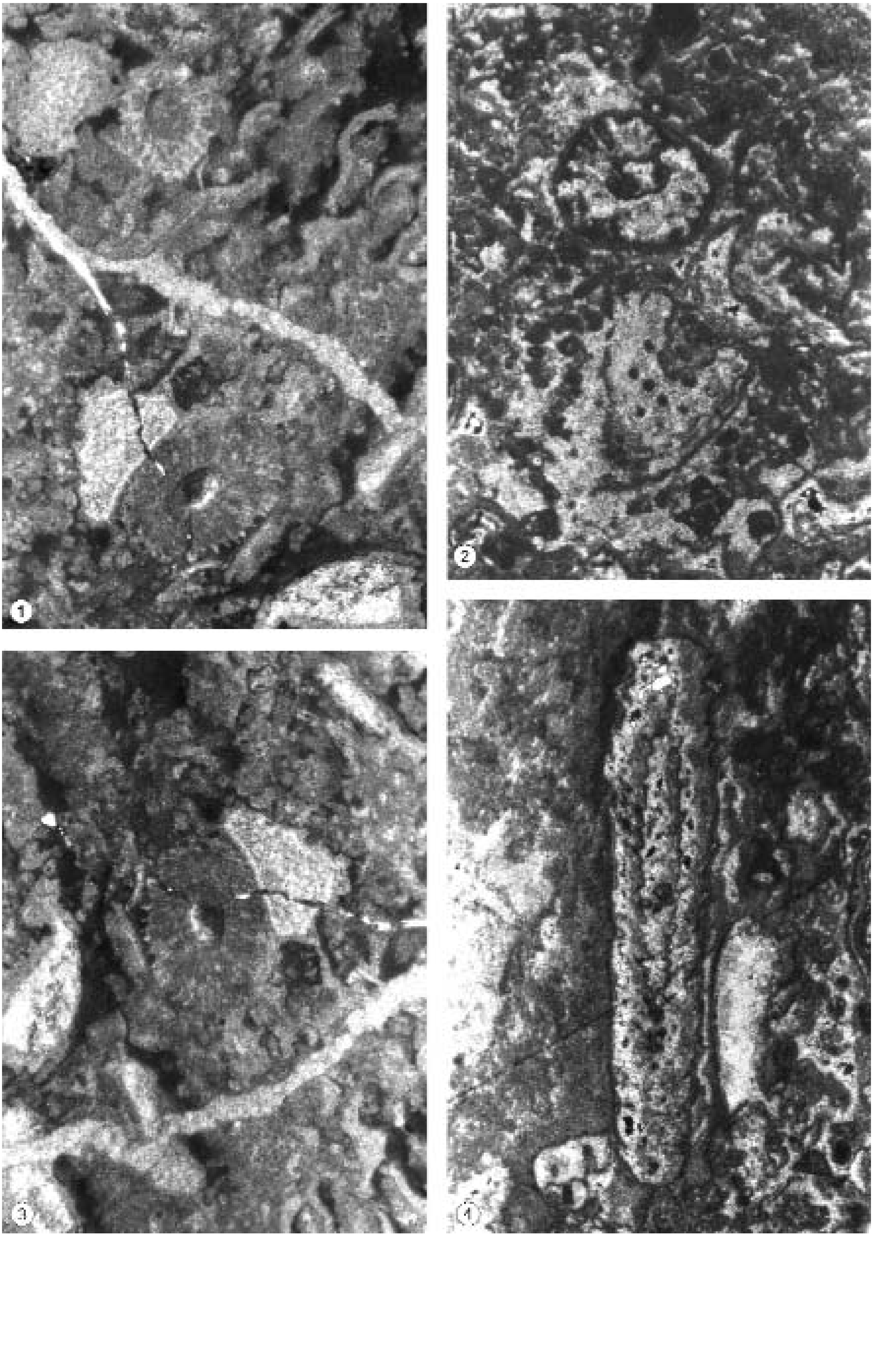
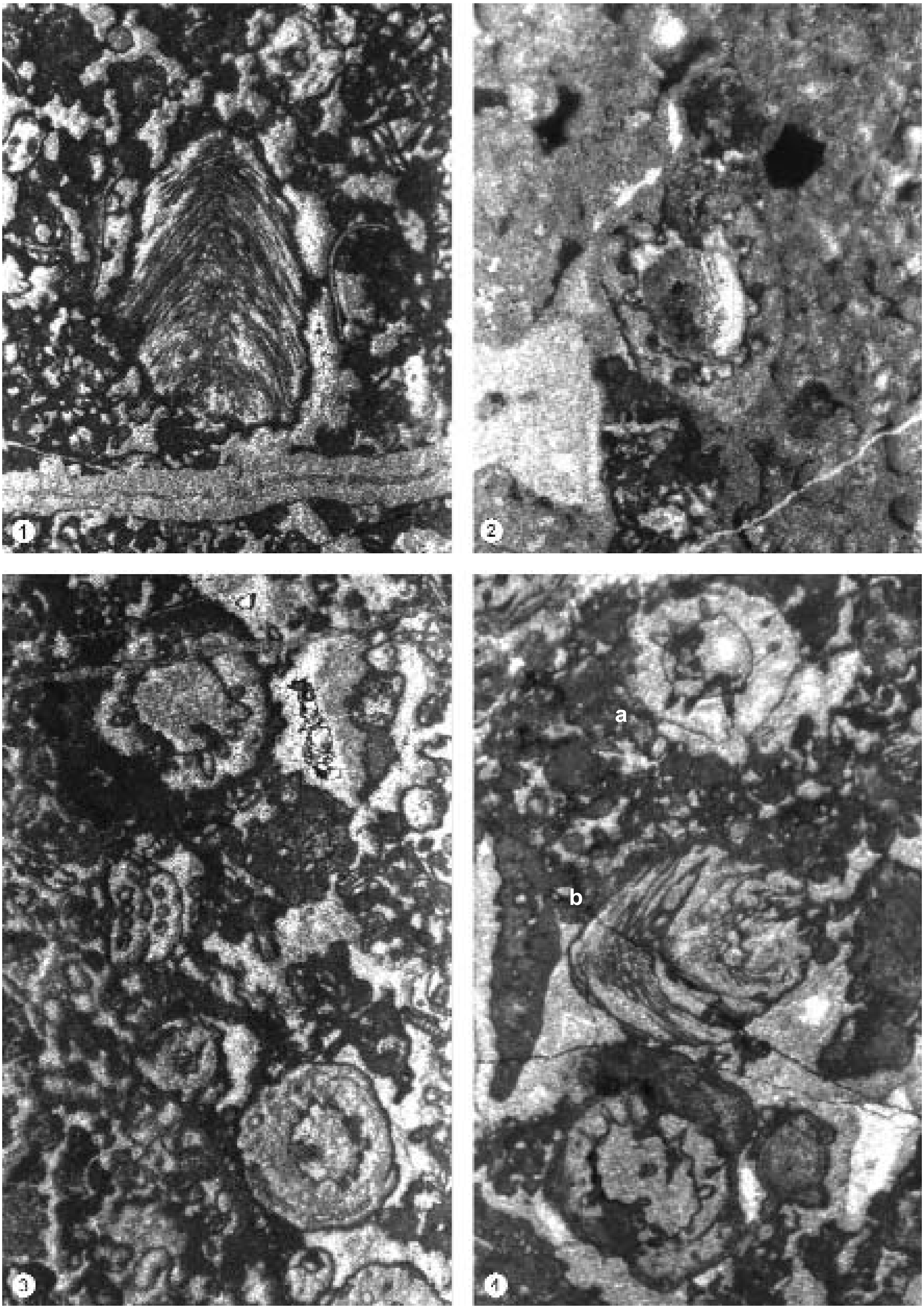


Plate D-II

1. *Teutloporella peniculiformis* OTT in GRANIER & DELOFFRE 1995, non 1963, Sample 1023 (Szentkirályszabadja), M: 13×.
2. *Physoporella pauciforata* var. *pauciforata* PIA ex BYSTRICKÝ, 1964, Sample 1016 (Szentkirályszabadja), M: 13×.
3. *Physoporella pauciforata* var. *pauciforata* PIA ex BYSTRICKÝ, 1964, Sample 1023 (Szentkirályszabadja), M: 13×.
4. *Physoporella pauciforata* var. *pauciforata* PIA ex BYSTRICKÝ (a), 1964 and *Teutloporella peniculiformis* OTT in GRANIER *et* DELOFFRE 1995, non 1963 (b), Sample 1023 (Szentkirályszabadja), M: 13×.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2
3
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a
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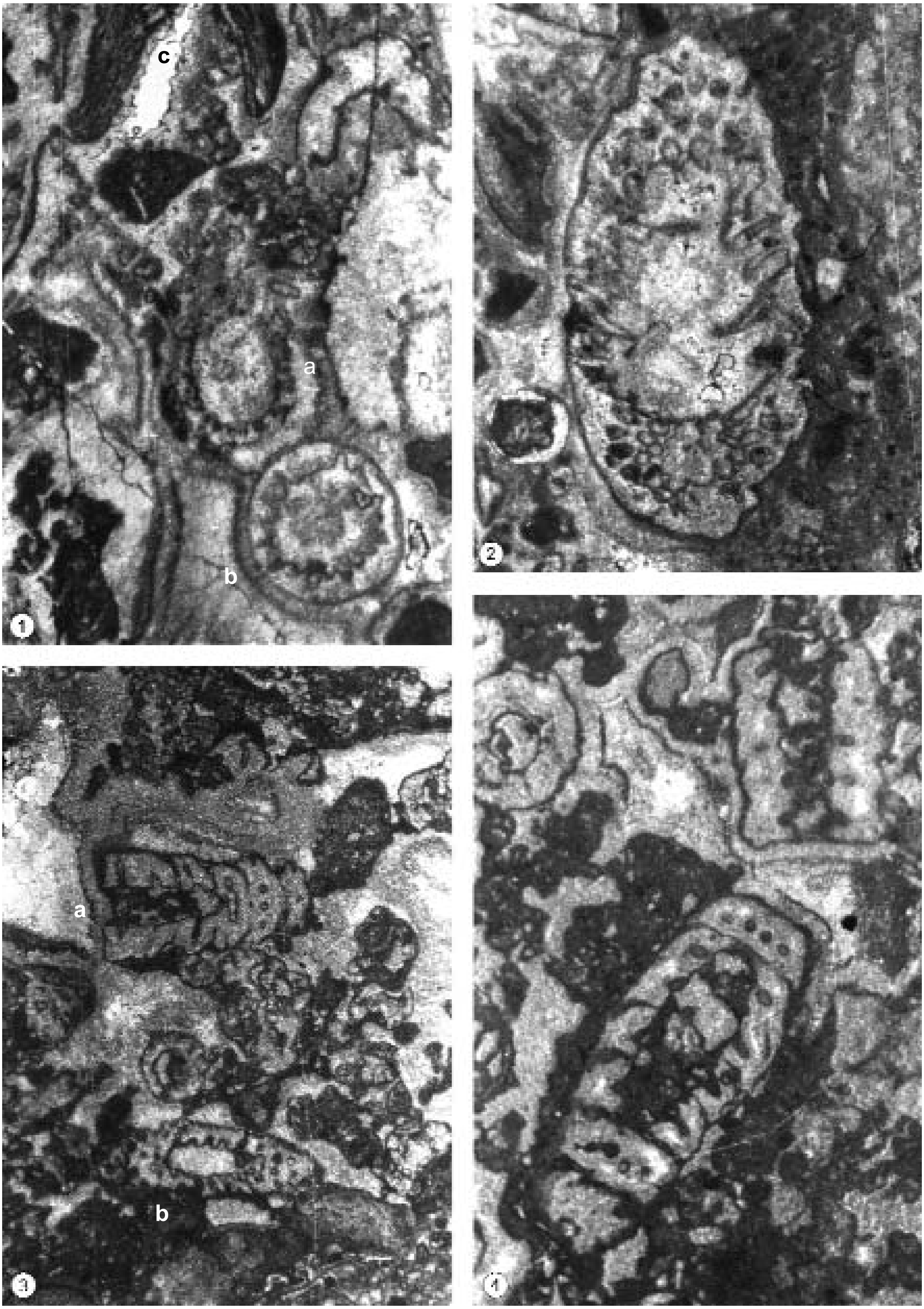
Plate D-III

1. *Anisoporella anisica* (ZANIN BURI, 1965) HURKA, 1969 (a), *Physoporella pauciforata* var. *undulata* PIA, 1935 (b) and *Teutloporella peniculiformis* OTT in GRANIER & DELOFFRE 1995, non 1963 (c), Sample 1019 (Szentkirályszabadja), M: 13×.
2. *Physoporella varicans* PIA, 1935, Sample 1019 (Szentkirályszabadja), M 13×.
3. *Physoporella pauciforata* var. *undulata* PIA, 1935 (a) and *Physoporella minutuloidea* HERAK, 1967 (b), Sample 1030 (Szentkirály-szabadja), M: 8×.
4. *Physoporella pauciforata* var. *undulata* PIA, 1935, Sample 1017 (Szentkirályszabadja), M: 13×.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b
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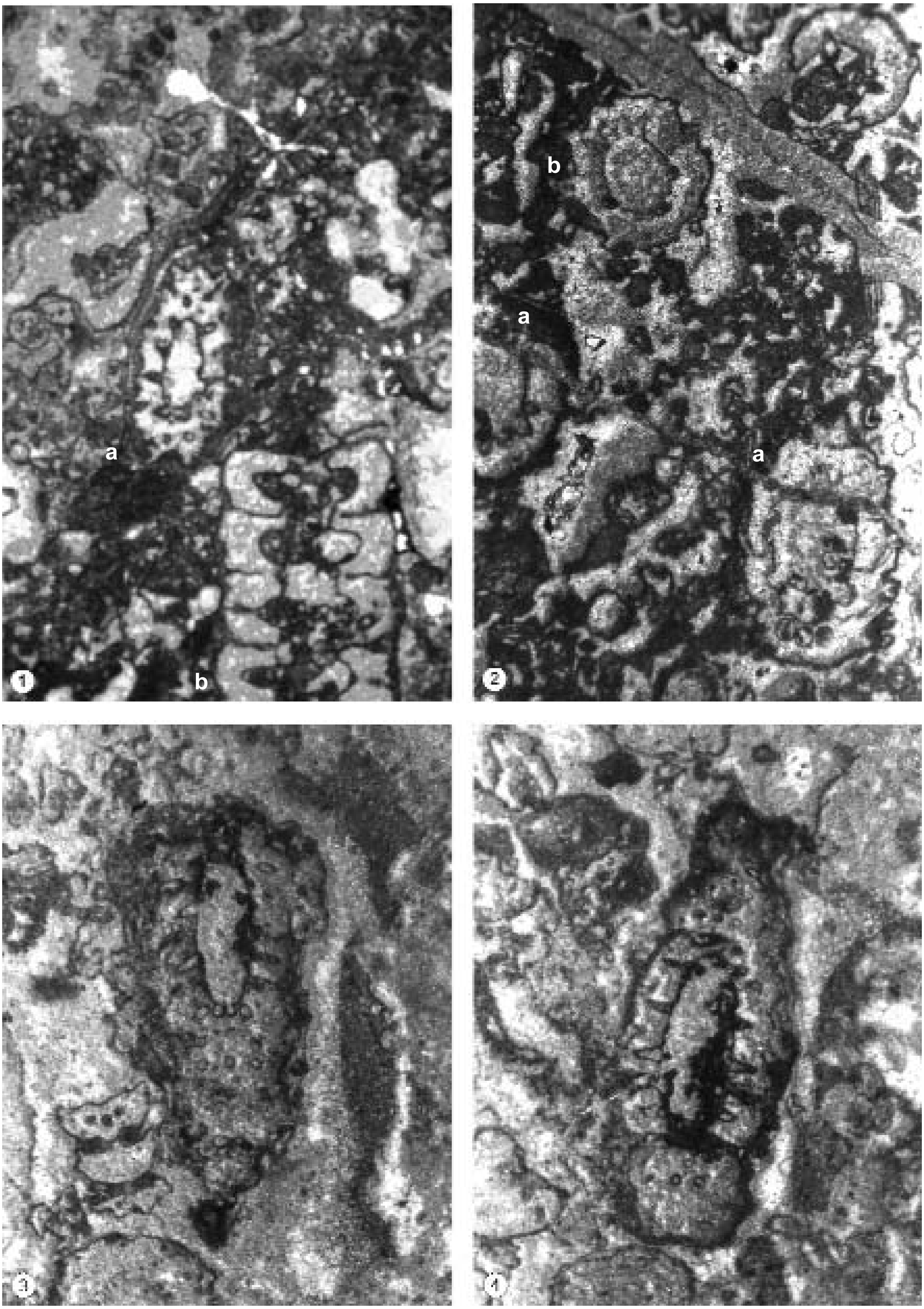
Plate D-IV

1. *Physoporella minutuloidea* HERAK, 1967 (a), *Physoporella pauciforata* var. *gemerica* BYSTRICKÝ, 1962 (b) Sample 1030 (Szentkirályszabadja), M: 13×.
2. *Physoporella pauciforata* var. *undulata* PIA, 1935 (a), *Physoporella pauciforata* var. *pauciforata* PIA ex BYSTRICKÝ (b), Sample 1023 (Szentkirályszabadja), M: 13×.
3. *Physoporella pauciforata* var. *undulata* PIA, 1935, Sample 1017 (Szentkirályszabadja), M: 13×.
4. *Physoporella pauciforata* var. *undulata* PIA, 1935, Sample 1017 (Szentkirályszabadja), M: 13×.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THE PELSONIAN AMMONOID FAUNA OF THE BALATON HIGHLAND

ATTILA VÖRÖS

INTRODUCTION

The first record of Pelsonian ammonoids at the Balaton Highland is connected to ZEPHAROVICH (1856) who, in his pioneering work, mentioned an indeterminable ammonoid fragment besides the description of several brachiopod taxa from the "Muschelkalk" of Köveskál.

The next, doubtful, report on a Pelsonian ammonoid is due to HAUER (1861) who noted that J. Kováts collected *"Ceratites binodosus* HAU.*"* near Nagyvázsony. These specimens were not found in the old collections in Budapest, and the species was not listed later by LÓCZY (1916, p. 116) from Kováts' locality (Alsócsepel-Kiserdőhegy, near Barnag). [New collections at the locality (nowadays called Vöröstó, Akol-domb) restricted the age of the exposed strata to the Late Illyrian (VÖRÖS 1998, p. 49).]

BÖCKH (1872, 1873) was the first who gave a comprehensive report on Pelsonian ammonoids from various localities of the Balaton Highland. Most of his specimens came from the "Muschelkalk" (corresponding to the Felsőörs Limestone Formation according to the present-day usage) and remarkably, he cited *"Ammonites Balatonicus"* even from the Megyehegy Dolomite. This first denomination of the above species, however remained *nomen nudum* until the next year, when MOJSISOVICS (1873) gave the valid description. The Anisian items of the magnificent monograph by MOJSISOVICS (1882) were partly based on Böckh's ammonoid material.

New fossil collections were carried out in the course of the ambitious international project entitled "Wissenschaftliche Erforschung des Balatonsees" (Scientific research of the Lake Balaton) led by L. Lóczy at the turn of the twentieth century. D. Laczkó, who was one of the most talented field geologists and productive fossil hunters of those times, gave an important stratigraphical contribution as well (LACZKÓ 1911). The ammonoids were determined and described by outstanding European specialists, *e.g.* DIENER (1899, 1900) and ARTHABER (1903) who listed *"Ceratites" zoldianus*, *"C." superbus* and *"C." gosaviensis*, and not less than 13 species of *Balatonites*. In the closing volume of the "Balaton Monograph", LÓCZY (1916) summarised the palaeontological results and gave lists of the ammonoid taxa determined by the above mentioned authors. Most of the listed Pelsonian ammonoids (including Mojsisovics' originals) have been kept in the collections (The Geological Museum of Hungary) of the Geological Institute of Hungary (GIH, Budapest).

After several decades, important excavations have been established at the Balaton Highland in the scope of the National Geological Key Section Programme (SZABÓ *et al.* 1980), coordinated by J. Fülöp and J. Haas. The new geological mapping project by the GIH resulted in significant improvement in the knowledge of Middle Triassic ammonoids of the Balaton Highland (BUDAI *et al.* 1999). These results were integrated in several geological syntheses (BUDAI & VÖRÖS 1992; BUDAI ET AL. 1993, 2001; BUDAI & HAAS 1997; HAAS & BUDAI 1995, 1999; VÖRÖS *et al.* 1997). In the early 1980's, field work done by I. Szabó and T. Budai (among others) stimulated new, systematic collections of fossils; most notably, the excavation and bed-by-bed collection of the key section Aszófő was carried out under the supervision of the present author who is indebted to G. Császár for the encouragement and support. Continuing collection of Pelsonian ammonoids at other localities were assisted (besides the above mentioned persons) by L. Dosztály(†), J. Pálfy and I. Szente. The rich fauna of the upper part of the Aszófő section was reviewed and illustrated by VÖRÖS (1987). The preliminary results of the simultaneous research at the classical Grossreifling localities were compared with those of Aszófő (TATZREITER & VÖRÖS 1991). The best of the newly collected specimens of *Balatonites balatonicus* of Aszófő was superbly illustrated in a methodical paper on morphometry by HOHENEGGER & TATZREITER (1992).

In the last years, a research project, supported by a grant from the Hungarian Scientific Research Fund (OTKA T26278) was devoted to revisit the accessible Pelsonian localities of the Balaton Highland, to make systematic collection of ammonoids and to update and summarise all available palaeontological and stratigraphical information on the Pelsonian Substage here. The present contribution is aimed to give a detailed systematic description of Pelsonian ammonoids collected in the last decades.

LOCALITIES

The localities providing the ammonoids described in the present chapter are shown in Figure A-1; their stratigraphy is described in a previous chapter ("Stratigraphy") of this volume.

In the course of our systematic field work we made efforts to visit the fossil localities mentioned in the classical literature and which provided the ammonoids kept in the museum of the Geological Institute of Hungary (GIH, Budapest). Some of these localities (*e.g.* "Csicsó", Recsek-hegy at Hidegkút, "Hegyesgyűr" at Nemesvámos, and the hills above Balatonfüred) were not available due to covering vegetation or growth of settlements, or at least they were not suitable for digging excavations.

We were more successful and collected a small Pelsonian ammonoid fauna at an old locality mentioned by LACZKÓ (1911) as "Veszprém, Alsó-erdő". This fauna came from the scree along the road leading from Veszprém to Csopak, a few hundred metres south of a ranch called Szabadság-puszta, or Miklósháza-puszta. The road-cut at the Megye-hegy, north of Vörösberény (inspected principally for the Reitzi Zone), provided only a single Pelsonian ammonoid.

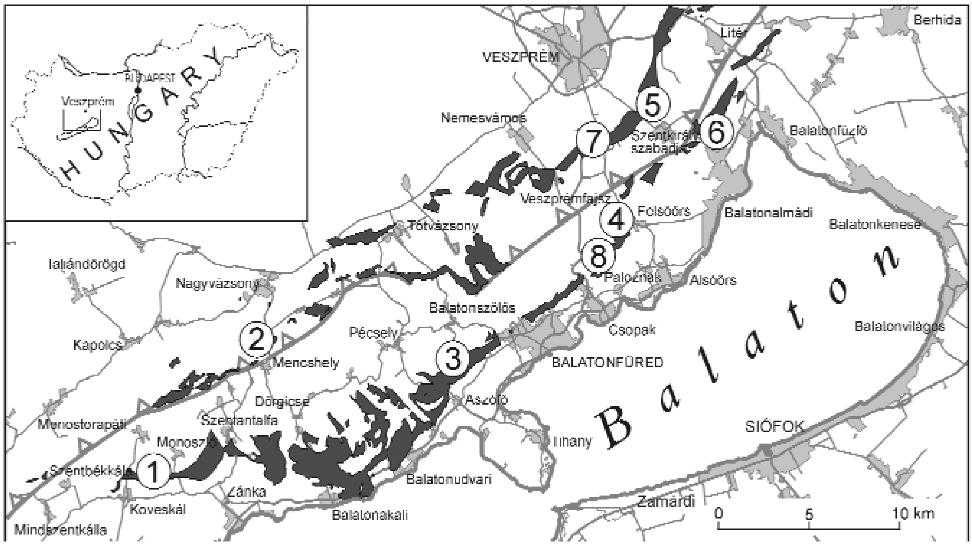

Figure A-1. Situation map showing the most important sections and localities of the Balaton Highland providing Pelsonian ammonoids. The distribution of Pelsonian formations is shown dark shaded (barbed line marks the Litér overthrust)
1 — Köveskál, Horog-hegy; 2 — Mencshely, Cser-tető; 3 — Aszófő; 4 — Felsőörs, Forrás-hegy; 5 — Szentkirályszabadja, airport quarry; 6 — Balatonalmádi, Megye-hegy; 7 — Veszprém, Szabadság-puszta; 8 — Paloznak Pat–1 borehole

A very fortunate, unique find of *Balatonites balatonicus* was discovered by O. Piros (GIH, Budapest) in an abandoned quarry at Szentkirályszabadja; this is the single occurrence of this ammonite in Pelsonian shallow water carbonate platform facies.

Systematic, bed-by-bed collection of fossils was undertaken in four important sections, at Köveskál (Horog-hegy), Mencshely (Cser-tető III), Aszófő and Felsőörs. Their detailed description was given in a previous part of this volume.

THE FAUNA

The systematic collections made in the last two decades provided several thousand specimens of Pelsonian ammonoids. Not less than 4423 ammonoids were determined at genus or species level; nearly three thousand of them representing *Balatonites* sp. indet. The remaining specimens were ranged into 29 taxa. Their specimen number data are presented per sections in Tables A-1, A-2, A-3, A-4 and A-5. The complete faunal list:

Proavites hueffeli ARTHABER, 1896
Norites gondola (MOJSISOVICS, 1869)
Norites falcatus ARTHABER, 1896
Alanites ? sp.
Ismidites cf. *marmarensis* ARTHABER, 1915
Ismidites sp., aff. *marmarensis* ARTHABER, 1915
Acrochordiceras cf. *damesii* (NOETLING, 1880)
Acrochordiceras carolinae MOJSISOVICS, 1882
Balatonites cf. *ottonis* (BUCH, 1849)

Table A-1. Stratigraphic distribution and number of collected specimens from the Köveskál (Horog-hegy) section

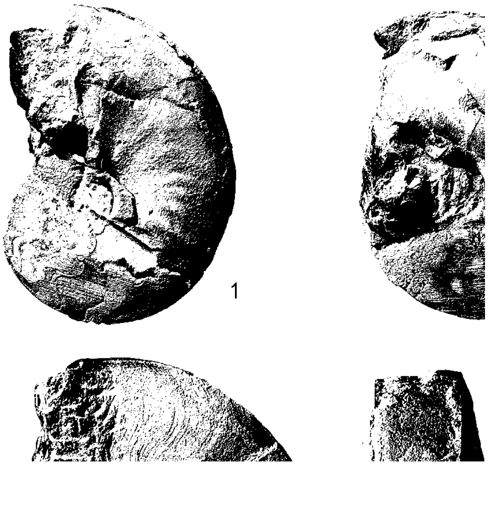

Table A-2. Stratigraphic distribution and number of collected specimens from the Mencshely (Cser-tető III) section

Cser-tető III.	*Proavites* cf. *hueffeli*	*Proavites* sp.	*Norites* cf. *gondola*	*Norites* sp.	*Acrochordiceras* sp.	*Balatonites balatonicus*	*Balatonites "jovis"*	*Bulogites* cf. *mojsvari*	*Bulogites* sp.	*Beyrichites* sp.	*Schreyerites* cf. *ragazzonii*	*Schreyerites* ? cf. *binodosus*	*Discoptychites* cf. *domatus*	*Discoptychites* sp.	*Ptychites* sp.	Σ	Cser-tető III.
Bed No.																	Bed No.
1										1						1	1
2																	2
3																	3
4																	4
5																	5
6																	6
7																	7
8																	8
9											1	1				2	9
10								2	3							5	10
11																	11
12																	12
13						3										3	13
14				1		1										2	14
15						2										2	15
16			1													1	16
17	1					1										2	17
18			1			12										13	18
19			1			18										19	19
20			5			22										27	20
21						13								3		16	21
22		1			1	6	3						3		2	16	22
23						1							3			4	23
24																	24
loose						12							1			13	loose
specimens	1	1	8	1	1	91	3	2	3	1	1	1	7	3	2	126	specimens

Balatonites balatonicus (MOJSISOVICS, 1873)
Balatonites balatonicus (MOJSISOVICS, 1873) morphotype *zitteli*
Balatonites gemmatus MOJSISOVICS, 1882
Balatonites egregius ARTHABER, 1896, morphotype *jovis*
Bulogites gosaviensis (MOJSISOVICS, 1882)
Bulogites zoldianus (MOJSISOVICS, 1882)
Bulogites multinodosus (HAUER, 1892)
Bulogites mojsvari (ARTHABER, 1896)
Beyrichites cadoricus (MOJSISOVICS, 1869)
Beyrichites beneckei (MOJSISOVICS, 1882)
Beyrichites cf. *reuttensis* (BEYRICH, 1867)
Beyrichites ? *sp.*
Schreyerites loretzi (MOJSISOVICS, 1882)
Schreyerites ragazzonii (MOJSISOVICS, 1882)
Schreyerites sp., aff. *splendens* ARTHABER, 1896
Schreyerites ? *binodosus* (HAUER, 1851)
Semiornites sp.
Discoptychites domatus (HAUER, 1851)
Judicarites cf. *euryomphalus* (BENECKE, 1865)
Noetlingites sp.

Table A-3. Stratigraphic distribution and number of collected specimens from the Aszófő I section

Aszófő I.	*Proavites hueffeli*	*Proavites* sp. (indet.)	*Norites gondola*	*Norites falcatus*	*Norites* sp. (indet.)	*Alanites* ? sp.	*Ismidites* cf. *marmarensis*	*Acrochordiceras carolinae*	*Acrochordiceras* sp. (indet.)	*Balatonites balatonicus*	*Balatonites "zitteli"*	*Balatonites "jovis"*	*Balatonites* sp. (indet.)	*Bulogites gosaviensis*	*Bulogites zoldianus*	*Bulogites multinodosus*	*Bulogites mojsvari*	*Bulogites* sp. (indet.)	*Beyrichites cadoricus*	*Beyrichites beneckei*	*Beyrichites* cf. *reuttensis*	*Beyrichites* ? sp.	*Beyrichites* sp. (indet.)	*Schreyerites loretzi*	*Schreyerites ragazzonii*	*Schreyerites* aff. *splendens*	*Schreyerites* ? *binodosus*	*Semiornites* sp.	*Discoptychites domatus*	*Discoptychites* sp. (indet.)	Σ	Aszófő I.
Bed No.																																Bed No.
96																				2			8		1							96
95																							1								1	95
94																							1		1						2	94
93																				2			3								5	93
92																				3											3	92
91																							1		2						3	91
89+90																					1	2	2		3		1				9	89+90
88																				1											1	88
87	1																			1			1		1						4	87
86																				1					1			1			3	86
85																				2			1					1			4	85
84																				1			1		2						4	84
83																									4						4	83
82																				1					2			1			4	82
81																				5			3		6						14	81
80																				1					5						6	80
79															8			2		3			4		13						30	79
78																		1		1					7			2			11	78
77																									7						7	77
76															1					1					3						5	76
75																		1							2			1			4	75
74																									1						1	74
73																		1					1	3							5	73
72																		1													1	72
71																	1	1					3								5	71
70					1												2	1					1								5	70
69																	1	2					2								5	69
68																		2													2	68
67																1		1													2	67
66																		1													1	66
65																		3													3	65
64																																64
63																		2													2	63
62																	1	4													5	62
61																1	2	2													5	61
60														2				5													7	60
59														3				14													17	59
57+58																																57+58
56																		2													2	56
55																		1													1	55
54								1																							1	54
53																																53
52					1																										1	52
51									1																						1	51
50																																50

Table A-3. Continuation

Aszófő 1	Procarnites kokeni	Procarnites sp. (indet.)	Norites gondola	Norites falcatus	Norites sp. (indet.)	Alanites ? sp.	Ismidites cf. marmarensis	Acrochordiceras carolinae	Acrochordiceras sp. (indet.)	Balatonites balatonicus	Balatonites "zalai"	Balatonites "jooi"	Balatonites sp. (indet.)	Bulogites gosaviensis	Bulogites zoldianus	Bulogites multinodosus	Bulogites mojsvari	Bulogites sp. (indet.)	Beyrichites cadoricus	Beyrichites beneckei	Beyrichites cf. reuttensis	Beyrichites ? sp.	Beyrichites sp. (indet.)	Schreyerites lorenzi	Schreyerites ragazzonii	Schreyerites aff. cylindrus	Schreyerites ? binodosus	Semiornites sp.	Discoptychites dieneri	Discoptychites sp. (indet.)	Σ	Aszófő 1
49																																49
48																																48
47																																47
46																																46
45					1																										1	45
44					2																		1								3	44
43			1		2								5																		8	43
42			2	1	3					1			4																		11	42
41					1					1			1																		3	41
40																																40
39													1																		1	39
38					1								1																		2	38
37																																37
36													1																		1	36
31–35													1																		1	31–35
30				2	5					2			3																		12	30
29			3		2								4																		9	29
28					4					1			3																		8	28
27			3	1	8								10																		22	27
26			4	1	6																										11	26
25			3		4																		1								8	25
24					10								2																		12	24
23	1				8					4	4		39										1								57	23
22				1	2					4			37											3							47	22
21	1			1	5						3		26							3			4	1							44	21
20										2			10						1				4								17	20
19					4					4	1		27						1				3	4							44	19
18				2	6					9	3		32						3				3	2							60	18
17	1			2	6					17			32						3	2			7	4							74	17
16				3	3					12			30										1								49	16
15			2	9	12					26			81						8	2			11	1		1					153	15
14	1		1	4	17	6		1		24	1		77						3				5	1							141	14
13		1		1	9	3	1			11		1	31										4	1							63	13
12	1		6	4	39	7				34			275						12				16						1		395	12
11		1	3	1	9					5	1		77						2				3								102	11
10				1	3					5			43										2	1							55	10
9			1	3	8					12			111						2				7								144	9
8			1	2	6					6			59											1							75	8
7				1	3					6			27																	1	38	7
6				2	18					16			170																		206	6
5		1	2	3	6					5	2		75																		94	5
4		2	1	2	13					8	1		98																		125	4
3	2	2	3	1	32					17	1	3	198																1		260	3
2										2		2	16																	1	21	2
1													2																		2	1
loose								2		3																			1		6	L (–37)
specimens	8	7	36	48	260	16	1	4	1	237	17	6	1629	5	9	2	7	47	35	32	1	2	106	22	61	1	1	6	3	2	2612	Spp.

Table A-4. Stratigraphic distribution and number of collected specimens from the Aszófő II section

Aszófő II.	*Proavites hueffeli*	*Proavites* sp. (indet.)	*Norites gondola*	*Norites falcatus*	*Norites* sp. (indet.)	*Ismidites* cf. *marmarensis*	*Ismidites* aff. *marmarensis*	*Acrochordiceras* cf. *damesi*	*Acrochordiceras carolinae*	*Acrochordiceras* sp. (indet.)	*Balatonites* cf. *ottonis*	*Balatonites gemmatus*	*Balatonites balatonicus*	*Balatonites* "*zitteli*"	*Balatonites* "*jovis*"	*Balatonites* sp. (indet.)	*Beyrichites* sp. (indet.)	*Discoptychites domatus*	*Discoptychites* sp. (indet.)	*Noetlingites* sp.	Σ	Aszófő II.
Bed No.																						Bed No.
1		1	1		20								11	1	2	158	4				198	1
2		1	6		22						1		7	2	1	255	4				299	2
3		2	3		15								4	5	1	147					177	3
4		8	12	1	55								5		1	259		3			344	4
5	2		9	3	45				5	1			26	1	4	340		1			437	5
6			1		1	1							1	2	1	45	1				53	6
7		2	3	1	3										2	25			6		42	7
8																						8
9																						9
10																						10
11																						11
12																						12
13																						13
14																						14
15																1					1	15
16					1										2	4	1				8	16
17												1				3				1	5	17
18			3				1					1			1	15					21	18
19					8							3				2					13	19
20																6					6	20
21												1				3					4	21
22					1											2					3	22
23																						23
24																						24
25		1														1					2	25
26		1																			1	26
27													1		1	4					6	27
28													2			1					3	28
29																2					2	29
30																1					1	30
31															1	1					2	31
32										1											1	32
33											1					1					2	33
34																						34
35																						35
36																						36
37																						37
38																						38
39																						39
40								1			2				1	2					6	40
41											2					2					4	41
loose													1								1	loose
specimens	2	16	38	5	171	1	1	1	5	2	6	6	58	11	18	1280	10	4	6	1	1642	specimens

The size of the ammonoids is usually small, rarely exceeds 10 cm in diameter. Larger, but less than 20 cm, individuals are represented by fragments. A single, extraordinarily large specimen reached 22 cm. The small (1–2 cm) or juvenile specimens are very frequent.

The state of preservation is variable, generally not very good. The majority of the fossils that were collected from the bituminous limestones, secondary silicification of the shell material is common. This is advantageous for the preservation of the external ornamentation but almost invariably conceals the suture lines. The body chambers were filled with muddy sediment and were more or less compressed and crushed during later compaction. The phragmocones are filled with calcite, or amorphous silica, or crystalline quartz internal cement. This material, withstanding compression, conserved the original shell form. In more marly facies, the shells were dissolved or replaced by sparry calcite; ammonoids occur here as internal moulds. In some cases only the body chambers were filled with sediment and can be extracted as internal moulds, while the empty or calcite-filled phragmocones get easily crumbled.

The fauna shows definite palaeobiogeographic relationship to those of the Southern Alps and the Northern Calcareous Alps, but many taxa are shared with the Dinaric region as well. The occurrence of a few, definitely Germanic faunal elements in the stratigraphically deepest horizons of the investigated sections points to connection with the Germanic facies realm in the Early Pelsonian.

Table A-5. Stratigraphic distribution and number of collected specimens from the Felsőörs section

Fossils	Proavites sp.	Beyrichites ? sp.	Acrochordiceras ? [illegible]	Balatonites sp.	Discoptychites sp.	Σ
Bed No.						
83			?			
82			1			1
81			?			
80						
79						
78			2	2	1	5
77			1			1
76						
75						
74	1		2		4	7
73		2				2
72			1	1		2
specimens	1	2	7	3	5	18

SYSTEMATIC DESCRIPTIONS

In the following descriptions the systematics of TOZER (1981) is used (except for *Discoptychites* what is taken here as a separate genus of the family Ptychitidae).

The material is deposited in the Geological and Palaeontological Department of the Hungarian Natural History Museum (Budapest). The figured specimens are under the inventory numbers M.89.31. and 2003.1.1 to 2003.96.1.

The dimensions (D = diameter, WH = whorl-height, WW = whorl-width, U = diameter of umbilicus,) are given in millimetres.

Order Ceratitida HYATT, 1884
Superfamily Noritaceae KARPINSKY, 1889
Family Meekoceratidae WAAGEN, 1895
Subfamily Meekoceratinae WAAGEN, 1895

Genus **Proavites** ARTHABER, 1896

Proavites hueffeli **ARTHABER, 1896**

Plate A-I, 1, 2, 3a–b, 4a–b; Figures A-2, A-3, A-4, A-5, A-6, A-7, A-8.

v * 1896 *Proavites Hüffeli* ART. — ARTHABER, Cephalopod. Reiflinger Kalke (I), p. 104, pl. X, figs. 2a–d.
v 1896 *Proavites marginatus* ART. — ARTHABER, Cephalopod. Reiflinger Kalke (I), p. 105, pl. X, figs 4a–c.
v 1896 *Proavites avitus* ART. — ARTHABER, Cephalopod. Reiflinger Kalke (I), p. 105, pl. X, figs 3a–c.
? 1896 *Proavites avitus* ARTH. — ARTHABER, Cephalopod. Reiflinger Kalke (II), p. 239, pl. XIV, figs 12a–c.
v 1934 *Proavites hueffeli,* ARTHABER. — SPATH, Catalogue British Museum, Trias, p. 273.
1980 *Proavites hueffeli* ARTHABER — GU *et al.*, Late Anisian from Doilungdeqen, p. 346, pl. I, figs. 1–5.
? 1986 *Proavites* cf. *proavitus* ARTHABER, 1896 — RAKÚS, Ammonites of Reifling Limestones, p. 80, pl. 1, fig. 2, text-figs. 6, 7.
v 1987 *Proavites hueffeli* ARTHABER, 1896 — VÖRÖS, Preliminary results from Aszófő, p. 55, pl. II, figs. 4a–b.
v 1987 *Proavites marginatus* ARTHABER, 1896 — VÖRÖS, Preliminary results from Aszófő, p. 55, pl. II, figs. 5a–b.
v 1991 *Proavites hueffeli* ARTHABER, 1896 — TATZREITER & VÖRÖS, Vergleich der pelsonischen..., p. 253, pl. 2, fig. 4.
v 1991 *Proavites margaritatus* ARTHABER, 1896. — TATZREITER & VÖRÖS, Vergleich der pelsonischen..., p. 256, pl. 2, figs. 10a–b.

Material: Twelve specimens of variable state of preservation, mostly with silicified shells; 10 from Aszófő, 1 from Mencshely (Cser-tető III) and 1 from Vörösberény (Megye-hegy section, bed 38).

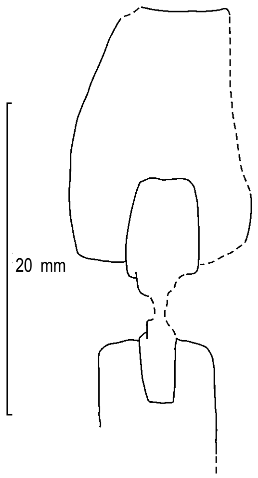

Figure A-2. Cross section of *Proavites hueffeli* ARTHABER, 1896, (2003.88.1.), Aszófő I, Bed 17, Balatonicus Zone, Cadoricus Subzone

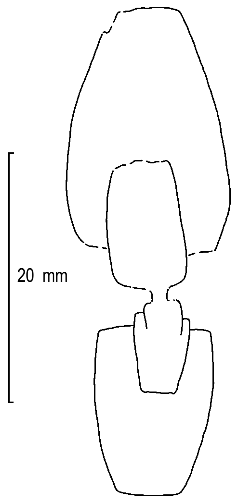

Figure A-3. Cross section of *Proavites hueffeli* ARTHABER, 1896, (2003.89.1.), Aszófő II, Bed 5, Balatonicus Zone, Balatonicus Subzone

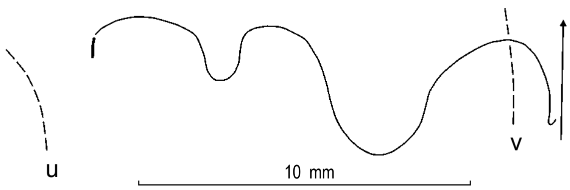

Figure A-4. Suture line of *Proavites hueffeli* ARTHABER, 1896, (2003.1.1.) Aszófő I, Bed 3, Balatonicus Zone, Balatonicus Subzone

u = umbilical shoulder, v = ventrolateral shoulder

Dimensions:

D	WH	WW	U
56.2	26.1	19.8	10.7
43.9	20.8	18.5	8.7
43.7	21.1	>14.0	9.0
43.5	21.6	14.7	6.3
37.0	19.2	13.6	6.0
32.2	16.7	14.0	5.0
28.0	13.8	11.5	5.0

Description: Small to medium sized ammonoids with involute coiling. The whorl-section is high trapezoidal. The umbilical wall is steep and forms a distinct shoulder with the flank on the phragmocone; on the body chamber the umbilical shoulder becomes subrounded. The flanks are gently convex, becoming flat ventrally; the venter is tabulate to slightly concave and bordered with marked ventrolateral shoulders. The ornamentation is very weak; it consists of faint, sinuous growth lines. On the body chamber these are slightly convex in the inner half of the flanks, then become strongly concave and plicate in the outer half. The peristome follows the same pattern: the sinuous lateral rims become projected and form a rectimarginate ventral protrusion.

The external suture lines are simple, goniatitic, with one large lateral lobe and one or two, weak, auxiliary umbilical elements. The width and depth of the lateral lobe may vary considerably; also, the shape of the second lateral saddle varies from regular, symmetric to being skewed internally (dorsally).

Remarks: P. hueffeli is the type species of the genus *Proavites*. ARTHABER (1896a, l. c.) described further two

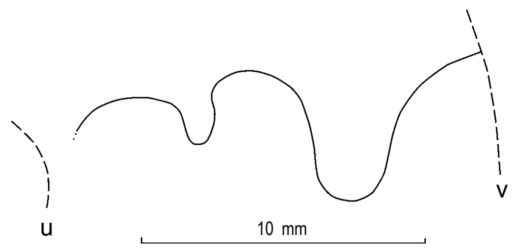

Figure A-5. Suture line of *Proavites hueffeli* ARTHABER, 1896, (2003.2.1.) Aszófő I, Bed 14, Balatonicus Zone, Cadoricus Subzone

u = umbilical shoulder, v = ventrolateral shoulder

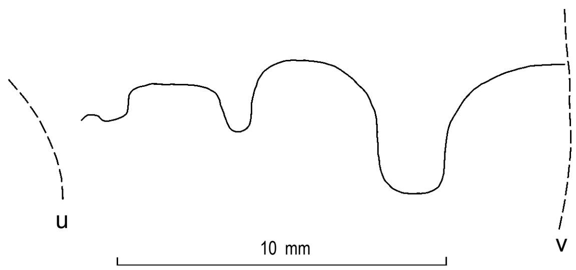

Figure A-6. Suture line of *Proavites hueffeli* ARTHABER, 1896, (2003.96.1.) Aszófő I, Bed 23, Balatonicus Zone, Cadoricus Subzone

u: umbilical shoulder, v: ventrolateral shoulder

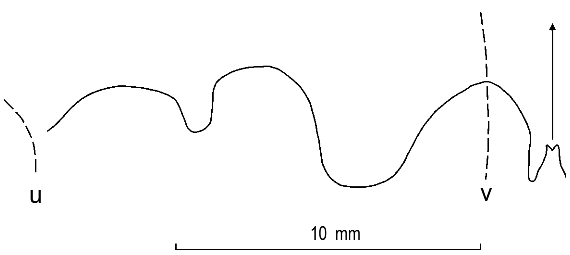

Figure A-7. Suture line of *Proavites hueffeli* ARTHABER, 1896, (2003.89.1.) Aszófő II, Bed 5, Balatonicus Zone, Balatonicus Subzone

u = umbilical shoulder, v = ventrolateral shoulder

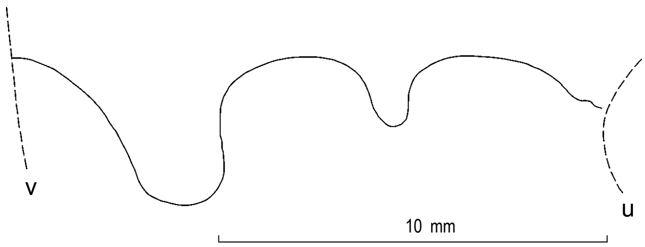

Figure A-8. Suture line of *Proavites hueffeli* ARTHABER, 1896, (2003.95.1.) Aszófő I, Bed 12, Balatonicus Zone, Cadoricus Subzone

u = umbilical shoulder, v = ventrolateral shoulder.

species of *Proavites* from the "Tiefengraben fauna": *P. marginatus* and *P. avitus* on the basis of slight differences in their umbilical and ventral parts and in their suture lines. The type material of the above three species was examined in the collection of the Geologische Bundesanstalt (Vienna). All three figured specimens are rather poorly preserved, they are fragmentary and crushed, partly in the umbilical partly in the ventral portions. Therefore the external morphological differences stressed by ARTHABER (l. c.) can not be endorsed. The deviations between the suture lines (relative depth of the ventral lobe; the relation between the first lateral saddle and the ventrolateral shoulder; the position of the first auxiliar lobe to the umbilical shoulder) do not seem diagnostic even in the original specimens and figures of ARTHABER (l. c.). The series of suture line drawings presented here (Figures A-4–A-8), corresponding to different stages of ontogeny, exhibits a very wide variation of the simple goniatitic suture. After all, it seems to be justified to unite these three nominal species under the name *P. hueffeli*, which has the "page-priority".

Distribution: *P. hueffeli* was described from the Middle Anisian Gutenstein Limestone of the Northern Calcareous Alps. Later on the species (including its synonyms) was found in the Anisian of the West Carpathians, the Dinarides (Han Bulog Limestones; SPATH, l. c.) and Tibet. At the Balaton Highland it was collected from three localities; it ranges from the Balatonicus Subzone to the Binodosus Subzone.

Family Noritidea KARPINSKY, 1889

Genus **Norites** MOJSISOVICS, 1869

Norites gondola **(MOJSISOVICS, 1869)**

Plate A-I, 5a–b, 6, 7; Figure A-9.

* 1869 *Ammonites Gondola* MOJS. nov. sp. — MOJSISOVICS, Cephalopoden-Fauna des alpinen Muschelkalkes, p. 584, pl. XV, figs. 3a–b.
v 1872 *Amm*. cfr. *Gondola* MOJS. — BÖCKH, A Bakony déli részének földtani viszonyai, p.75.
1882 *Norites gondola* E. v. MOJSISOVICS. — MOJSISOVICS, Ceph. mediterr. Triasprovinz, p. 202, pl. LII, figs. 5–8.
? 1896 *Norites gondola* MOJS. — ARTHABER, Cephalopod. Reiflinger Kalke (I), p. 88.
v 1896 *Norites* cfr. *gondola* MOJS. — ARTHABER, Cephalopod. Reiflinger Kalke (I), p. 89, pl. VII, figs. 12a–b.
v ? 1896 *Norites psilodiscus* ART. — ARTHABER, Cephalopod. Reiflinger Kalke (I), p. 92, pl. VIII, figs. 4a–c.
? 1901 *Norites gondola* MOJS. var. nov. — REIS, Eine Fauna des Wettersteinkalkes, p. 90, pl. IV, figs. 24, 25.
? 1904 *Norites gondola* MOJSISOVICS 1869. — MARTELLI, Boljevici presso Vir nel Montenegro, p. 97, pl. VIII, figs. 1a–b.
? 1912 *Norites* (?) sp. indet. cf. *Norites gondola* MOJS.) — ARTHABER, Fossilfunde am Monte Cucco, p. 355, pl. XVII, figs. 10a–b, 11a–b.
v 1916 *Norites gondola* MOJS. — LÓCZY, Die geologischen Formationen der Balatongegend, p.111.
v 1916 *Norites gondola* MOJS. — LÓCZY, Die geologischen Formationen der Balatongegend, p.112.
v 1916 *Norites gondola* MOJS. — LÓCZY, Die geologischen Formationen der Balatongegend, p.115.
v 1934 *Norites gondola* (MOJSISOVICS).– SPATH, Catalogue British Museum, Trias, p. 281.
1969 *Norites gondola* (MOJSISOVICS, 1869) — GAETANI, Anisico Giudicarie, p. 514, pl. 36, figs. 1, 2.
v 1987 *Norites* cf. *gondola* (MOJSISOVICS, 1869) — VÖRÖS, Preliminary results from Aszófő, p. 55, pl. II, figs. 2a–b.
v 1991 *Norites gondola* (MOJSISOVICS, 1869) — TATZREITER & VÖRÖS, Vergleich der pelsonischen..., p. 253.
v 2002 Norites cf. gondola (MOJSISOVICS, 1869) — VÖRÖS & PÁLFY, The Pelsonian at Köveskál, p. 55. pl. I, figs. 2a–b.

Material: 85 specimens of variable state of preservation, mostly with silicified shells; 74 from Aszófő, 8 from Mencshely (Cser-tető III) and 3 from Köveskál (Horog-hegy).

Dimensions:

D	WH	WW	U
40.6	22.4	>12.0	4.8
24.6	14.0	7.8	3.4
23.0	11.5	7.2	3.0
21.1	10.5	5.3	3.1
17.7	9.2	5.3	2.5
17.0	9.3	5.2	2.2
16.6	8.8	5.0	2.1
15.7	8.7	5.0	2.1
15.6	8.2	4.5	2.4

Description: The specimens are rather small-sized for the genus. The coiling is very involute; the whorl-section is high and narrow trapezoidal. The umbilicus is narrow and deep. The umbilical wall is steep and forms a rather sharp shoulder with the flanks. The flanks are gently and evenly convex and meet the flat venter with a marked ventrolateral shoulder. Signs of faint, keel-like crests along the ventrolateral shoulders are visible. The ornamentation is very weak; it

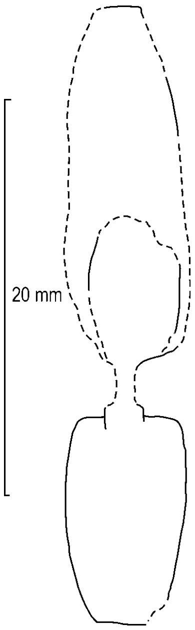

Figure A-9. Cross section of *Norites gondola* (MOJSISOVICS, 1869), (2003.84.1.), Aszófő I, Bed 14, Balatonicus Zone, Cadoricus Subzone

consists of faint, gently convex growth lines. The peristome follows the same pattern and has a somewhat trumpet-like appearance (Pl. A-I, 7).

The details of the suture are unknown; a weathered specimen (Pl. A-I, 6) shows a ceratitic suture with a small lateral lobe and at least four auxiliary elements at 18 mm diameter.

Remarks: *N. gondola* is the type species of the genus *Norites*. ARTHABER (1896a, b) described further four species of *Norites* from the Tiefengraben and Rahnbauerkogel faunas, from which *N. psilodiscus* and *N. apioides* can tentatively be ranged into *N. gondola*; examination of the types, kept in the collection of the Geologische Bundesanstalt (Vienna), revealed that these poorly preserved, crushed specimens has no real diagnostic features for distinguishing them from *N. gondola*. On the other hand, *N. falcatus* (ARTHABER, 1896) can be maintained as an independent species on the basis of its different ornamentation (sinuous growth lines in contrast to convex in *N. gondola*).

The assignment of the two specimens figured by ARTHABER (1912, l. c.) to *N. gondola* is very doubtful because one of them is too broad, the other is too much compressed in relation to the standard of this species. BÖCKH's (1872, l. c.) and LÓCZY's (1916, l. c.) records of *N. gondola* from the Balaton Highland were confirmed in the collections museum of the Geological Institute of Hungary (Budapest), the inventory numbers and localities of the respective specimens are given in parentheses: (T.2263., Aszófő), (T.100., T.105., Köveskál), (T.149., T.328., Mencshely).

Distribution: *N. gondola* was described from the Anisian Schreyeralm Limestone of the Northern Calcareous Alps. Later on the species (including its synonyms) was found in other Anisian localities of the Northern Calcareous Alps, the Southern Alps and the Dinarides (Han Bulog Limestones; MARTELLI, l. c., SPATH, l. c.). At the Balaton Highland (besides the old collections) it was collected from three localities; its range is restricted to the Balatonicus and Cadoricus Subzones.

Norites falcatus ARTHABER, 1896

Plate A-I, 8, 9, 10.

* 1896 *Norites falcatus* ART. — ARTHABER, Cephalopod. Reiflinger Kalke (I), p. 89, pl. VIII, figs. 1a–c.
v ? 1896 *Norites arcuatus* ARTH. — ARTHABER, Cephalopod. Reiflinger Kalke (II), p. 227, pl. XIV, figs. 9a–c.
? 1963 *Norites* cf. *arcuatus* ARTHABER 1896. — ASSERETO, Anisico della Val Camonica, p. 28, fig. 6, pl. I, fig. 9.
v 1987 *Norites* cf. *falcatus* ARTHABER, 1896 — VÖRÖS, Preliminary results from Aszófő, p. 55.
v 1987 *Norites* cf. *arcuatus* ARTHABER, 1896 — VÖRÖS, Preliminary results from Aszófő, p. 55.
v 1987 *Norites* cf. *psilodiscus* ARTHABER, 1896 — VÖRÖS, Preliminary results from Aszófő, p. 55.
v 1991 *Norites* cf. *falcatus* ARTHABER, 1896 — TATZREITER & VÖRÖS, Vergleich der pelsonischen..., p. 253.

Material: 53 specimens of variable state of preservation, mostly with silicified shells; all from Aszófő.
Dimensions:

D	WH	WW	U
41.8	21.7	>9.0	5.5
41.5	20.8	>9.0	6.0
36.1	18.8	>8.0	5.1
31.8	16.2	>8.5	4.0

Description: Medium sized, involute, compressed *Norites*. The whorl-section is high and narrow trapezoidal. The umbilicus is narrow and deep. The umbilical wall is steep and forms an angular shoulder with the gently convex flank. Some of the latter features are not well seen on the body chambers which are almost always crushed. The tabulate venter is rather narrow and is bordered by very thiny keels protruding from the outer surface of the shell. The ornamentation consists of fine, sometimes irregular, sinuous, falcate growth lines. The (rarely preserved) peristome follows the same pattern: it is convex in the internal part and concave in its ventral part (Pl. A-I, 9).

Suture lines are not visible.

Remarks: N. falcatus was described by ARTHABER (1896, l. c.) along with three other new species of *Norites* (*N. apioides, N. arcuatus, N. psilodiscus*) from the Anisian of Grossreifling. After the examination of the type material in the collection of the Geologische Bundesanstalt (Vienna), *N. psilodiscus* and *N. apioides* (based on poorly preserved, smooth specimens) can tentatively be ranged into *N. gondola* (MOJSISOVICS, 1869). *N. falcatus* (ARTHABER, 1896) can be maintained as an independent species on the basis of its different ornamentation (sinuous growth lines in contrast to convex in *N. gondola*). *N. arcuatus* has a similar ornamentation and general figure, therefore it is thought to be conspecific with *N. falcatus*, which latter name is maintained here, by page priority.

The previous record of *N. psilodiscus* by VÖRÖS (1987, l. c.) in fact relates to specimens with sinuous ornamentation.

Distribution: N. falcatus was described from the Middle Anisian Gutenstein Limestone of the Northern Calcareous Alps. Later on the species (including its synonyms) was found in the Anisian of the Southern Alps. At the Balaton Highland it was collected only in the Aszófő section, where it ranges through the Balatonicus and Cadoricus Subzones.

Superfamily Dinaritaceae MOJSISOVICS, 1882
Family Dinaritidae MOJSISOVICS, 1882
Subfamily Khvalynitinae SHEVYREV, 1968

Genus Alanites SHEVYREV, 1968

When establishing this genus, SHEVYREV (1968, p. 187) differentiated it from other genera of the subfamily (*e.g. Ismidites* ARTHABER, 1915) by its flat (tabulate) venter and by characters of its suture. Later, several representatives of *Alanites* and *Ismidites* were found in North America (SILBERING & NICHOLS 1982, BUCHER 1992a, 1992b, TOZER 1994). Especially the figures given by SILBERLING & NICHOLS (1982, figs. 8, 10) demonstrate that the sutures of *Alanites* and *Ismidites* are very variable, and that the simple, *Alanites*-type suture and the more advanced *Ismidites*-type suture may occur within one species (l. c. fig. 8). In fact the difference between these two genera seems to become less defined and the flat venter remained the single relevant distinctive morphological feature.

***Alanites* ? sp.**
Plate A-VII, 3.

v 1987 *Hollandites* ? sp. — VÖRÖS, Preliminary results from Aszófő, p. 56.

Material: 16 specimens (fragmentary moulds of body chambers); all from Aszófő.

Dimensions: None of the specimens was suitable for measuring.

Description: The fragments represent lateral and ventral parts of body chambers of small to medium-sized specimens. The coilig appears to be moderately evolute. The lateral flanks are flat to gently convex. The tabulate to slightly arched venter is bordered by rather marked ventrolateral shoulders. The flanks are ornamented with weak, gently projected ribs, becoming stronger ventrally. At the ventrolateral shoulder, the ribs form feeble clavi, then abruptly weaken on the venter. Longitudinal striae develop on the flanks and, especially strongly, on the venter.

Sutures are not visible.

Remarks: These specimens were previously (VÖRÖS 1987, l. c.) tentatively attributed to *Hollandites*. Rather similar forms with tabulate venter, ribs and strigation were published from Nevada by SILBERING & NICHOLS (1982, pl. 28, figs. 21–25) and BUCHER (1992b, pl. 5, figs. 6–8). Especially the latter gave support to the identification of the fragments from Aszófő.

Distribution: The genus *Alanites* was recorded hitherto only from the Bithynian. At the Balaton Highland this form was collected only in the Aszófő section, where its range is restricted to the Cadoricus Subzone.

Genus **Ismidites** ARTHABER, 1915
***Ismidites* cf. *marmarensis* ARTHABER, 1915**
Plate A-VII, 1a–b, 2a–b; Figure A-10.

* 1915 *Ismidites marmarensis* ARTH. — ARTHABER, Die Trias von Bithynien, p. 185, fig. 15b, pl. XV, figs. 9, 10a–c.
? 1982 *Ismidites* aff. *I. marmarensis* ARTHABER — SILBERLING & NICHOLS, Molluscan fossils Humboldt Range, p. 20, fig. 10, pl. 28, figs. 19–20.
1988 *Ismidites marmarensis* ARTHABER, 1914 — FANTINI SESTINI, Anisian Ammonites from Gebze, p. 50, pl. 9, fig. 1.
? 1992 *Ismidites* cf. *I. marmarensis* ARTHABER — BUCHER, Ammonoids of the Shoshonensis Zone, p. 431, pl. 10, figs. 5–6.

Material: Two incomplete specimens from Aszófő.

Dimensions:

D	WH	WW	U
22.7	12.0	9.3	3.8

Description: Small-sized ammonoids for the genus, with rather involute coiling. The whorl-section is high oval to trapezoidal. The umbilical wall is steep, with pronounced umbilical shoulder. The flanks are gently convex and pass

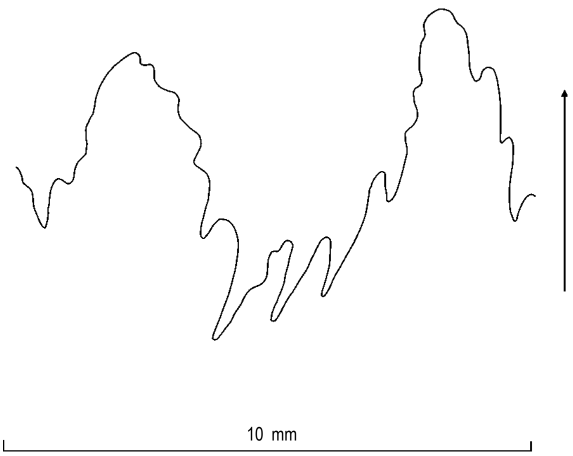

Figure A-10. Suture line of *Ismidites* cf. *marmarensis* ARTHABER, 1915, (2003.49.1.), Aszófő I, Bed 13, Balatonicus Zone, Cadoricus Subzone

gradually to the well arched venter. The flanks are ornamented with fine, gently sinuous ribs. The ribs reach their maximum strength at around the transition from the flanks to the venter; here they form weak clavi; then they vanish on the venter.

The external suture line is dominated by the wide and deeply indented lateral lobe. The first lateral saddle is high and narrow, the second lateral saddle is wider. Both saddles are incised up to their top, and their axis is gently curved, following the coiling.

Remarks: This indistinct form can easily be mistaken for some *Beyrichites*, but the sutures are highly diagnostic for the subfamily Khvalynitinae SHEVYREV, 1968. The relationship between *Ismidites* and *Alanites* SHEVYREV, 1968 were shortly discussed above, at the latter genus.

Distribution: *I. marmarensis* was described from the Bithynian of Turkey, later on, similar forms were published from Nevada, from the Bithynian and lowermost Pelsonian (lowermost Shoshonensis Zone). At the Balaton Highland it was collected only in the Aszófő section, in the Balatonicus and Cadoricus Subzones.

Ismidites sp., aff. *marmarensis* ARTHABER, 1915

Plate A-VII, 12a–b; Figure A-11.

Material: A single, incomplete specimen from Aszófő.

Dimensions: The specimen was not suitable for measuring.

Description: Medium-sized specimen for the genus, with rather involute coiling. The whorl-section is high oval. The umbilical margin seems to be marked. The flanks are very gently convex and pass gradually to the equably arched venter. The flanks are ornamented with slightly projected, weak ribs and longitudinal striae. The ribs become stronger and projected near the rim of the venter, forming gentle clavi. The strigation is most pronounced at the middle of the flanks, where three, equally spaced longitudinal elements are well seen. The middle of these, at around the mid-flank, is the strongest, and it forms a distinct spiral row of nodes as crossing the radial ribs.

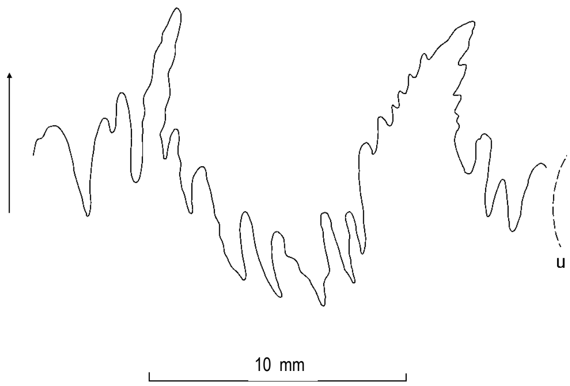

Figure A-11. Suture line of *Ismidites* sp., aff. *marmarensis* ARTHABER, 1915, (2003.48.1.), Aszófő II, Bed 18, Balatonicus Zone, Balatonicus Subzone
u = umbilical margin

The visible part of the external suture line is dominated by the very wide and deeply indented lateral lobe. The first lateral saddle is deeply dissected and, in fact, it seems to be reduced to a finger-like, slightly incised, narrow saddle. The second lateral saddle is wider, pointed and incised, reminding a maple-leaf. The axes of the saddles are markedly bent along the coiling.

Remarks: This form is very similar to *I. marmarensis* in shape and in its suture, but the marked strigation makes it distinctly different.

Distribution: The specimen was collected in the Aszófő section, in the Balatonicus Subzone.

Superfamily Ceratitaceae MOJSISOVICS, 1879
Family Acrochordiceratidae ARTHABER, 1911

Genus **Acrochordiceras** HYATT, 1877

Acrochordiceras cf. damesii (NOETLING, 1880)

Plate A-II, 1a–b, Plate A-III, 1; Figure A-12.

* 1880 *Ammonites (Acrochordiceras) Damesii* sp. n. — NOETLING, Trias in Niederschlesien, p. 334, pl. XV, figs. 1, 1a, 1b.
non 1887 *Acrochordiceras Damesi* NOETLING. — HAUER, Cephalopoden von Han Bulog, p. 22, pl. V, figs. 2a–c.
1990 *Acrochordiceras damesi* NOETLING, 1880 — DZIK, The ammonite Acrochordiceras, p. 61, fig. 3, pl. 13, 1a, b.
? 1999 *Acrochordiceras* aff. *damesi* NOETLING, 1880 — KAIM & NIEDŹWIEDZKI, Middle Triassic ammonoids from Silesia, p. 97, figs. 3A–E, 4B–C, 5B.
1999 *Acrochordiceras damesii* — URLICHS, Cephalopoden im Muschelkalk, p. 345, fig. 5.

Material: A single, extraordinarily large, poorly preserved, diagenetically deformed and partly worn specimen from Aszófő (Aszófő II; Bed 40 or 41).

Dimensions:

D	WH	WW	U
>215.0	102.0	>67.0	?48.0

Description: A very large, moderately involute, rather compressed *Acrochordiceras*. The poor preservation reduces the confidence of the following morphological description. The whorl-section is high oval. The umbilicus is of medium width. The umbilical margin is rounded, but appears to be well marked on the body chamber. The flanks are gently convex and pass gradually to the narrow, arched venter. The ornamentation consists of gently concave, projected, rather strong ribs, becoming very strong on the body chamber. The ribs seem to pass through the venter and bear weak nodes. The strongest ribs on the body chamber are not tuberculate. Probably due to erosion, the umbilical margin shows no strong nodes.

Only a small portion of a suture line is preserved on the diagenetically deformed (dextrally skewed) part of the phragmocone (Figure A-10). This is the central part of the wide lateral lobe, showing moderately deep dentition.

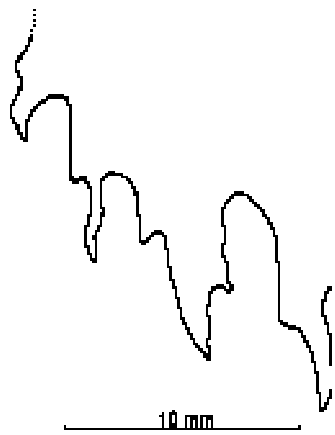

Figure A-12. Suture line of *Acrochordiceras* cf. *damesii* (NOETLING, 1880), (2003.72.1.), Aszófő II, Bed 40 or 41, Ismidicus Zone, Ottonis Subzone

Remarks: *A. damesii* is a well-documented species of the Germanic Lower Muschelkalk. DZIK (1990, l. c.) and URLICHS (1999, l. c.) re-figured the holotype of NOETLING (1880). The large internal mould clearly shows the details of the suture line with the very wide, almost subcircular and moderately indented lateral lobe. *A. haueri* ARTHABER, 1911, based on the figures by HAUER (1887, l. c.), is closely related but differs by its very deeply incised suture and by being less compressed. *A. carolinae* MOJSISOVICS, 1882 is usually also more inflated and has 5–6 ribs per one umbilical node on the body chamber, whereas this ratio is 3.5 to 1 in *A. damesi* (DZIK 1990, fig. 5).

The determination of the specimen from Aszófő is very uncertain due to its poor preservation. Nevertheless, the large size, the strongly compressed whorls and the not deeply indented character of the large lateral lobe speak in favour of its identification with *A. damesi*.

Distribution: This species is regarded as a typical form of the Germanic Lower Muschelkalk. It occurred as a single specimen in the lowermost fossiliferous beds (40 or 41) of the Aszófő section (Ottonis Subzone).

Acrochordiceras carolinae MOJSISOVICS, 1882

Plate A-I, 11, 12, 13, 14a–b; Figure A-13.

v * 1882 *Acrochordiceras Carolinae* E. v. MOJSISOVICS — MOJSISOVICS, Ceph. mediterr. Triasprovinz, p. 141, pl. XXVIII, figs. 14a–b., pl. XXXVI, figs. 3a–b.
1882 *Acrochordiceras Fischeri* E. v. MOJSISOVICS — MOJSISOVICS, Ceph. mediterr. Triasprovinz, p. 142, pl. XXXIII, figs. 8a–b.
v 1896 *Acrochordiceras undatum* ARTH. — ARTHABER, Cephalopod. Reiflinger Kalke (II), p. 235, pl. XV, figs. 2a–d.
1905 *Acrochordiceras Carolinae* MOJS. — AIRAGHI, Ammoniti triasici del M. Rite in Cadore, p. 249, pl. VIII, fig. 6.
v 1934 *Acrochordiceras carolinae* MOJSISOVICS — SPATH, Catalogue British Museum, Trias, p. 395.
1958 *Acrochordiceras carolinae* MOJSISOVICS — SACCHI VIALLI & VAI, Fauna Triassica Bresciana, p. 69, pl. IV, fig. 17.
? 1973 *Acrochordiceras* cf. *carolinae* MOJSISOVICS — PELOSIO, Trias medio di Asklepieion, p. 153, pl. XVII, figs. 3a–b.
1980 *Acrochordiceras carolinae* MOJSISOVICS — GU *et al.*, Late Anisian from Doilungdeqen, p. 350, pl. II, figs. 12, 13.
? 1980 *Acrochordiceras fischeri* MOJSISOVICS — GU *et al.*, Late Anisian from Doilungdeqen, p. 351, pl. II, figs. 8, 9.
v 1987 *Acrochordiceras* cf. *carolinae* MOJSISOVICS, 1882 — VÖRÖS, Preliminary results from Aszófő, p. 56, pl. II, fig. 3.
v 1991 *Acrochordiceras* cf. *carolinae* MOJSISOVICS, 1882 — TATZREITER & VÖRÖS, Vergleich der pelsonischen..., p. 252, pl. 2, fig. 2.
v 1991 *Acrochordiceras fischeri* MOJSISOVICS, 1882 — TATZREITER & VÖRÖS, Vergleich der pelsonischen..., p. 252.
v 1991 *Acrochordiceras undatum* ARTHABER, 1896. — TATZREITER & VÖRÖS, Vergleich der pelsonischen..., p. 256, pl. 2, figs. 5a–b.

Material: Nine specimens of variable state of preservation, mostly with silicified shells; all from Aszófő.

Dimensions:

D	WH	WW	U
57.4	31.3	>22.0	10.4
54.5	28.1	?	10.7
34.7	20.8	16.1	>4.5
27.3	14.4	>11.0	6.0

Description: Small to medium sized acrochordiceratids. The coiling is moderately involute, with slightly compressed whorls. The body chambers are usually crushed. The whorl-section is subcircular in the inner whorls and tends to high oval in the outer whorls of the phragmocone. The umbilical wall is steep to overhanging in the outer whorls. The flanks

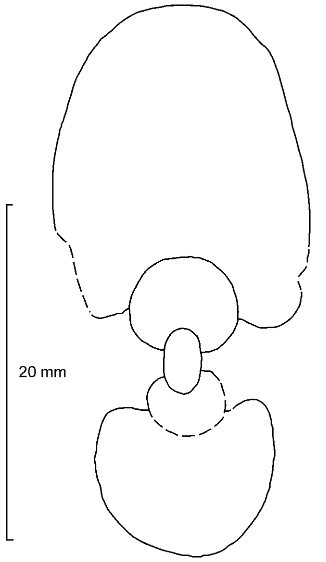

Figure A-13. Cross section of *Acrochordiceras carolinae* MOJSISOVICS, 1882, (2003.14.1.), Aszófő I, loose (around Bed 3), Balatonicus Zone, Balatonicus Subzone

and the venter form a continuous curve. The ornamentation consists of umbilical nodes and simple, strong, slightly projected ribs or rather plicae. The umbilical nodes are rather irregular in shape, strength and position; their number varies between 6 and 8 on the last whorl/body chamber. The ribs or plicae start at the umbilical margin or at the nodes and, with increasing amplitude, they run across the venter where they reach maximum strength. The ratio between the number of nodes and ribs is 3 to18 on a half-whorl.

Suture lines are not visible.

Remarks: *A. carolinae* was described by MOJSISOVICS (1882, l. c.) along with *A. fischeri* and *A. pustericum*. This latter, as a finely ribbed form with no umbilical nodes, is kept as a distinct, clearly separated species. On the other hand, the shape and ornamentation of *A. carolinae* and *A. fischeri* shows the same basic features, and the weak differences given by MOJSISOVICS (l. c.: degree of inflation, coarseness of ornamentation) seem to be connected by transitions, shown also by the specimens from Aszófő. However, the ratio between the number of nodes to number of ribs seems to be more or less constant, around 1 to 5. Therefore the two nominal species are taken as conspecific and the name *A. carolinae* is maintained by page priority. This goes for the earlier records of *A. fischeri* by GU *et al.* 1980, l. c.) and TATZREITER & VÖRÖS (1991, l. c.), as well.

The holotype of *A. undatum* ARTHABER, 1896 was examined in the collection of the Geologische Bundesanstalt (Vienna) and was re-figured by TATZREITER & VÖRÖS (1991, pl. 2, figs. 5a–b); it apparently falls within the range of variability of *A. carolinae*.

A. damesii (NOETLING, 1880) differs from *A. carolinae* by being more compressed and by having 3–4 ribs per one umbilical node on the body chamber (see DZIK 1990, fig. 5), whereas this ratio is 5–6 to 1 in *A. carolinae*.

Distribution: *A. carolinae* was described from the Anisian Schreyeralm Limestone of the Northern Calcareous Alps. Later on, the species and its synonyms were recorded from the Southern Alps, from the Hallstatt (Han Bulog) Limestone of the Dinarides and Epidhavros, and Tibet. At the Balaton Highland it was collected only in the Aszófő section, where it ranges through the Balatonicus and Cadoricus Subzones.

Family Balatonitidae SPATH, 1951

Genus **Balatonites** MOJSISOVICS, 1879
***Balatonites* cf. *ottonis* (BUCH, 1849)**
Plate A-I, 15.

* 1849 *Ammonites Ottonis* — BUCH, Über Ceratiten, p. 18, pl. IV, figs. 4, 5, 6.
? 1867 *Ammonites Ottonis* — BEYRICH, Über einige Cephalopoden, p. 110 (partim), pl. IV, figs. 1a-c (? non fig. 2).
? 1880 *Ammonites (Ceratites) Ottonis* BUCH. — NOETLING, Trias in Niederschlesien, p. 334, pl. XIV, figs. 12a, 12b.
1882 *Balatonites* cf. *Ottonis* (v. BUCH) E. v. M. — MOJSISOVICS, Ceph. mediterr. Triasprovinz, p. 78, pl. V, fig. 1., pl. VI, figs. 1a–b.
v ? 1915 *Balatonites* cfr. *Ottonis* BUCH sp. — ARTHABER, Die Trias von Bithynien, p. 129, pl. XII, figs. 7a–c.
? 1915 *Balatonites Zimmeri* nov. spec. — RASSMUSS, Alpine Cephalopoden im niederschlesischen Muschelkalk, p. 292, pl. 3, figs. 1, 3.
v 1987 *Balatonites* cf. *ottonis* (BUCH, 1848) — VÖRÖS, Preliminary results from Aszófő, p. 56.
? 1988 *Balatonites* aff. *ottonis* (BUCH, 1848) — FANTINI SESTINI, Anisian Ammonites from Gebze, p. 58, pl. 11, fig. 4.
1990 *Balatonites ottonis* (von BUCH, 1849) — DZIK, The ammonite Acrochordiceras, p. 65, pl. 15, figs. 1a–b, 2.
? 1990 *Balatonites zimmeri* RASSMUSS, 1915 — DZIK, The ammonite Acrochordiceras, p. 64, pl. 14, figs. 3a–b.
v 1991 *Balatonites* cf. *ottonis* (BUCH, 1848) — TATZREITER & VÖRÖS, Vergleich der pelsonischen..., p. 253.
1994 *Balatonites* cf. *ottonis* — BALINI, Triassic cephalopods of the Curionii collection, p. 58, pl. 5, figs. 1, 2.
v 1998 *Balatonites* cf. *ottonis* (BUCH, 1848) — VÖRÖS, A Balatonfelvidék triász ammonoideái, p. 15.
? 1999 *Balatonites zimmeri* — URLICHS, Cephalopoden im Muschelkalk, p. 345, fig. 6.
1999 *Balatonites ottonis* (BUCH, 1849) — KAIM & NIEDŹWIEDZKI, Middle Triassic ammonoids from Silesia, p. 109, figs. 10C, 11A, 11B.
1999 *Balatonites ottonis* (BUCH 1849) — BRACK *et al.,* Pelagic successions, p. 862 (partim), figs. 6a–d (non figs 6e–f).

Material: Six, poorly preserved, incomplete specimens from Aszófő.
Dimensions:

D	WH	WW	U
>81.0	>28.0	?	38.0
?	29.0	?24.0	?

Description: The best preserved specimen is an incomplete cast of a body chamber with some remnants of the phragmocone. It is a medium-sized *Balatonites*. The coiling is moderately evolute. The whorl-section is compressed, high oval to subquadrate; the umbilical margin is subrounded. The details of the ornamentation are visible only on one flank, the other side and the venter is worn. The rather widely spaced strong ribs are almost radial, slightly projected. Instead of bifurcation, secondary ribs are inserted in the outer half of the flank. Tuberculation is restricted to the inner half of the primary ribs. The strongest row of tubercles runs at the middle of the flank.

Suture lines are not visible.

Remarks: *B. ottonis* was founded on material from the Germanic Basin by BUCH (l. c.). One of the specimens figured by BEYRICH (1867, pl. IV, figs. 1a–c) can be taken as a *B. ottonis*, whereas the other (l. c., fig. 2) seems more similar to *B. balatonicus* (MOJSISOVICS, 1873). NOETLING's figures (1880, l. c.) are not informative enough to definitely decide their specific attribution.

Later, *B. ottonis* was recorded also in Alpine localities (MOJSISOVICS, l. c.), and the possibility of a wider morphological interpretation of the species appeared. This wider interpretation, preferred also by the present author, was indirectly supported by the recent, morphometric study of *Balatonites* populations by HOHENEGGER & TATZREITER (1992) where they grouped most of the previously described nominal *Balatonites* species into two, variable species: *B. balatonicus* and *B. egregius*. *B. ottonis* was not involved. It is tempting to consider *B. ottonis* as a third, important, variable species embracing the very evolute, less tuberculate forms with strong, widely spaced ribbing. This idea (suggested also by KAIM & NIEDŹWIEDZKI, 1999, p. 109, BRACK *et al.* 1999, p. 863, and TATZREITER 2001, p. 159) ought to be confirmed by morphostatistical studies. The copious material collected by BRACK *et al.* 1999) in Lombardy at Mojsisovics's classical locality (Val dei Gatti, Schilpario) will hopefully permit a detailed study (H. RIEBER, pers comm.). Tentatively accepting this interpretation, some of the Silesian *Balatonites* species erected by RASSMUSS (1915) (first of all *B. zimmeri*) may taken as conspecific with *B. ottonis*. The items of the above synonymy are mostly repeated illustrations of earlier records: *e.g.* BALINI 1994 after MOJSISOVICS 1882; DZIK after BUCH 1849 and RASSMUSS 1915; URLICHS 1999 after RASSMUSS 1915.

The original specimens of ARTHABER (1915, Bithynien) were examined when they were on loan from Stuttgart at F. Tatzreiter in Vienna. The specimen figured by ARTHABER (l. c., pl. XII, figs. 7a–c) somewhat differs from *B. ottonis* (and most other *Balatonites,* except perhaps *B. hystrix* ARTHABER, 1896) in its ventral ornamentation: instead of a distinct nodose keel, here the projected lateral ribs form chevron-like row of crests arcoss the fastigate venter.

B. ottonis seems to be the earliest species of the genus *Balatonites* both as its date of publication and as its stratigraphical record is concerned. In Silesia it occurs in a narrow horizon within the Upper Gogolin Beds representing the upper part of the Lower Anisian and lowermost part of the Pelsonian (KAIM & NIEDŹWIEDZKI 1999). In the Alpine region the occurrences are not well dated, but BRACK *et al.* (1999) concluded that their *ottonis*-fauna (in the Angolo Formation) lies deeper than the base of the Prezzo Limestones in the Stabol Fresco section and this separate level below other *Balatonites* faunas can be correlated with the Germanic facies areas. In Aszófő, *B. ottonis* appears in the lowermost fossiliferous beds (VÖRÖS 1998, l. c.).

Distribution: This species is a typical form of the Lower Muschelkalk of the Germanic facies area but occurs also in the Anisian of the Southern Alps. At the Balaton Highland it was collected only in the Aszófő section, where it ranges from the Ottonis Subzone to the lower part of the Balatonicus Subzone.

Balatonites balatonicus (MOJSISOVICS, 1873)

Plate A-I, 16, 17, 18; Plate A-II, 2a–b, 3a–b; Plate A-III, 2a–b, 3a–b, 4, 5;
Plate A-IV, 1, 2a–b, 3, 4a–b; Figures A-14, A-15, A-16.

v 1872 *Ammonites Balatonicus* sp. n. — BÖCKH, A Bakony déli részének földtani viszonyai, p. 62.

v * 1873 *Trachyceras Balatonicum* E. v. MOJSISOVICS — MOJSISOVICS, Über einige Trias-Versteinerungen, p. 426 (partim), pl. XIII, figs. 3a–b, (non figs. 4a–b).

v 1882 *Balatonites balatonicus* E. v. MOJSISOVICS — MOJSISOVICS, Ceph. mediterr. Triasprovinz, p. 78 (partim), pl. IV, figs. 2a–b, 4, 5a–b, 6a–b (non figs. 3a–b), pl. XXX, fig. 20.

? 1894 *Balatonites balatonicus* - E. MOJS: — TOMMASI, Fauna del calcare conchigliare di Lombardia, p. 132, pl. II, fig. 11.

v non 1896 *Balatonites balatonicus* MOJS. — ARTHABER, Cephalopod. Reiflinger Kalke (I), p. 60, pl. VI, figs. 2a–d, 3a–c.

v 1903 *Balatonites lineatus* ARTH. — ARTHABER, Neue Funde im Muschelkalk des südlichen Bakony, p. 11.

v 1903 *Balatonites* cfr. *Scylla* ARTH. — ARTHABER, Neue Funde im Muschelkalk des südlichen Bakony, p. 11.

1912 *Balatonites balatonicus* MOJS. — ARTHABER, Fossilfunde am Monte Cucco, p. 350, pl. XVII, figs. 7a–b.

v 1916 *Balatonites jubilans* ARTH. var. — LÓCZY, Die geologischen Formationen der Balatongegend, p.111 and 115.

v 1916 *Balatonites balatonicus* MOJS. — LÓCZY, Die geologischen Formationen der Balatongegend, p.115.

? 1966 *Balatonites balatonicus* (MOJSISOVICS), 1873 — ASSERETO, Cefalopodi anisici in Val Romana, p. 597, pl. 39, fig. 2.

non 1980 *Balatonites balatonicus* (MOJSISOVICS) — GU *et al.*, Late Anisian from Doilungdeqen, p. 353, pl. II, figs. 26, 27, text-fig. 7.

? 1986 *Balatonites* ex gr. *balatonicus* (MOJSISOVICS, 1873) — RAKÚS, Ammonites of Reifling Limestones, p. 80, pl. 1, figs. 7, 8, text-fig. 8.

v 1987 *Balatonites balatonicus* (MOJSISOVICS, 1872) — VÖRÖS, Preliminary results from Aszófő, p. 56, pl. I, figs. 1a–b, 2.

v 1987 *Balatonites variesellatus* ARTHABER, 1896 — VÖRÖS, Preliminary results from Aszófő, p. 56.

? 1988 *Balatonites balatonicus* (MOJSISOVICS, 1873) — FANTINI SESTINI, Anisian Ammonites from Gebze, p. 57, pl. 11, fig. 5.

v 1991 *Balatonites balatonicus* (MOJSISOVICS, 1873). — TATZREITER & VÖRÖS, Vergleich der pelsonischen..., p. 253, pl. 1, fig. 3.
v 1992 *Balatonites balatonicus* (MOJSISOVICS, 1873) — HOHENEGGER & TATZREITER, Morphometric methods, p. 811, figs. 18/1-3, 18/9-13, 19/7-11, 19/16-17.
? 1995 *Balatonites balatonicus* (MOJSISOVICS, 1873) — MIETTO & MANFRIN, Triassic ammonoid standard scale, p. 547, pl. 1, fig. 5.
v 1998 *Balatonites balatonicus* (MOJSISOVICS) — VÖRÖS, A Balatonfelvidék triász ammonoideái, p. 74, pl. I, figs. 2, 3.
v 2002 *Balatonites balatonicus* (MOJSISOVICS, 1872) — VÖRÖS & PÁLFY, The Pelsonian at Köveskál, p. 55. pl. I, figs. 1a–c, 3, 4.

Material: 396 specimens of variable preservation; mostly with silicified shells; 295 from Aszófő, 91 from Mencshely (Cser-tető III), 8 from Köveskál (Horog-hegy), 1 from Veszprém ("Szabadság-puszta") and 1 from Szentkirályszabadja ("airport quarry").

Dimensions:

D	WH	WW	U
>95.0	31.7	>18.0	38.5
76.0	26.5	>15.0	30.3
72.0	27.0	?	27.0
65.0	22.0	15.0	26.0
63.1	23.0	>12.6	23.2
63.0	24.0	15.0	22.0
61.0	22.0	14.0	23.0
59.0	21.0	12.0	22.0
56.0	20.0	12.3	21.4
52.0	20.0	10.0	19.0
50.0	19.0	10.0	16.0
49.6	18.6	>9.5	17.2
49.2	17.7	14.4	18.9
45.0	17.0	9.0	16.0
43.0	16.0	9.0	16.5
43.0	16.0	10.0	15.0
41.0	15.0	9.0	16.0
39.0	14.0	8.5	14.5
38.8	14.8	>7.0	14.2
38.0	14.5	9.0	13.0
36.0	13.0	7.0	13.0
35.0	13.0	6.0	13.0
34.0	14.0	8.0	11.5
34.0	13.0	8.0	11.0
34.0	13.0	6.5	11.0
34.0	12.2	8.0	12.9
33.1	12.7	6.5	12.8
33.0	12.0	7.0	11.0
31.0	12.0	6.0	11.0
29.0	11.0	6.0	10.0
28.0	11.0	7.0	10.0
27.0	10.0	6.0	9.0
26.0	10.0	6.0	9.5
25.0	10.0	5.5	9.0
24.0	9.0	5.0	9.0
23.0	8.0	5.0	8.0
22.0	9.0	6.0	7.5
20.0	8.0	5.0	7.0

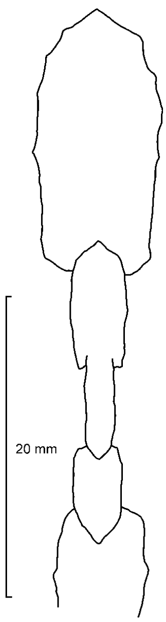

Figure A-14. Cross section of *Balatonites balatonicus* (MOJSISOVICS, 1873), (2003.81.1.), Mencshely (Cser-tető III), Bed 19, Balatonicus Zone, Cadoricus Subzone.

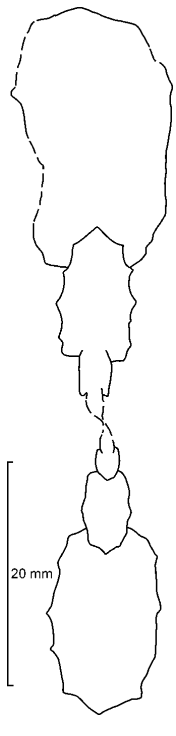

Figure A-15. Cross section of *Balatonites balatonicus* (MOJSISOVICS, 1873), (2003.76.1.), Aszófő II, Bed 5, Balatonicus Zone, Balatonicus Subzone

Description: Medium to large sized *Balatonites*. The conch is compressed, the coiling is moderately evolute. The whorl-section is high oval to subpentagonal. The umbilical wall is steep in the inner whorls and becomes subrounded during growth. The flanks are gently convex, almost flat. On the phragmocone, the venter is fastigate and forms a marked edge with the flanks; the degree of fastigation decreases on the body chamber. The ornamentation consists of strong, gently projected, prorsiradiate ribs and variable tubercles. The ribbing is rather irregular: in some cases the ribs simply become stronger ventrally, bifurcation is rare, insertion of secondary ribs may start either at the umbilical shoulder or near the ventrolateral margin. Projected ribs continue on the venter forming a chevron pattern. Weak, intercalatory riblets may occur throughout on the shell. Ordinarily, there are three rows of tubercles on the flanks and a fourth one on the ventral keel. One to four accessory tubercles may appear irregularly on the ribs of the flanks, more frequently in the inner, rarely in the outer (ventral) half. The main lateral tubercles may develop into strong spines; the ventrolaterals tend to form elongated clavi. The ventral tubercles tend to form a serrate keel. The ornamentation of the inner whorls shows two types (connected with transition: one with coarse ornamentation with widely spaced, strong ribs and tubercles and another with almost smooth surface and widely spaced constrictions (this may be termed as *Cuccoceras* stage).

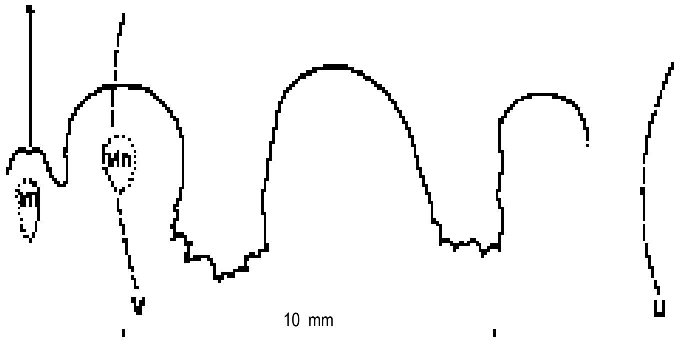

Figure A-16. Suture line of *Balatonites balatonicus* (MOJSISOVICS, 1873), (2003.16.1.), Mencshely (Cser-tető III), Bed 15, Balatonicus Zone, Cadoricus Subzone

u = umbilical margin, v = ventrolateral margin, vn = ventral node, vln = ventrolateral node

The external suture lines were rarely observed. The simple ceratitic suture shows one deep lateral lobe and one or two, moderately deep, auxiliary umbilical elements. The second lateral saddle is larger than the first one. The frilling of the lobes is irregular but simple.

Remarks: *B. balatonicus* is the type species of the genus *Balatonites*. Except the suture lines, it was profusely illustrated by MOJSISOVICS (1873, 1882); the holotype, kept in the collections (The Geological Museum of Hungary) of the Geological Institute of Hungary (GIH, Budapest) under the inventory number T.349. is re-figured herein (Plate A-IV, 1). The type series of Mojsisovics contains, besides typical *B. balatonicus*, another form which is regarded by the present author as belonging to *"B. egregius,* morphotype *jovis"* (MOJSISOVICS 1873, pl. XII, figs. 4a–b; MOJSISOVICS 1882, pl. IV, figs. 3a–b). This specimen is available in the collections of the GIH (Budapest) under the inventory number T.145. *B. balatonicus*, even in this restricted sense, is still a very variable species and was only rarely misinterpreted by later workers. The figure given by TOMMASI (1894, l. c.) is rather vague but approximately shows the main characters of *B. balatonicus* (N. B.: in the explanation of the plate the specimen is named as *B. ottonis*). The specimen from Val Romana figured by ASSERETO (1966, l. c.) shows unusually dense ribbing. The Tibetan specimen figured by GU *et al.* 1980, l. c.) seems to be a typical representative of the "morphotype *jovis*".

In a recent morphometric study of *Balatonites* populations, HOHENEGGER & TATZREITER (1992) grouped the majority of the previously described nominal *Balatonites* species into two, variable species: *B. balatonicus* and *B. egregius*. In accordance with this interpretation, ARTHABER's specimens from Grossreifling (1896, l. c.) are excluded from *B. balatonicus*.

The older records from the Balaton Highland were revised in the collections of the GIH (Budapest); the inventory numbers and localities of the respective specimens are given in parentheses, according to authors. ARTHABER (1903, l. c.: *B. lineatus* T.1520, Veszprém, Alsó-Erdő), *B.* cfr. *scylla* T.1523, same locality); LÓCZY (1916, l. c.: *B. jubilans* T.2393, Aszófő, T148, Mencshely); LÓCZY (1916, l. c.: *B. balatonicus* T.137., T. 140., 150., Mencshely).

RAKÚS (1986, l. c.) figured a very poorly preserved specimen but the illustrated sutures seem to support the attribution.

B. balatonicus is represented in the rich *Balatonites* collection of the Natural History Museum (London). This material, purchased from V. Havelka and regrettably not registered by SPATH (1934), came from Han Bulog-type limestones from Mali Durmitor (Montenegro) and Stavljan,Volujak (Bosnia).

Distribution: *B. balatonicus* was described from the Anisian of the Balaton Highland and was recorded at many localities of the Alps, West Carpathians, Dinarides and Turkey. During the recent collections, at the Balaton Highland it was found at five localities; its range is restricted to the Balatonicus and Cadoricus Subzones.

Balatonites balatonicus **(MOJSISOVICS, 1873)**
morphotype ***zitteli***
Plate A-IV, 5; Plate A-V, 1, 2, 3.

? 1882 *Balatonites Zitteli* E. v. MOJSISOVICS — MOJSISOVICS, Ceph. mediterr. Triasprovinz, p. 80 (partim), pl. V, figs. 2a–b, (non pl. XIX, figs. 3a–b).

v ? 1916 *Balatonites lineatus* ARTH. — LÓCZY, Die geologischen Formationen der Balatongegend, p. 114.

v 1987 *Balatonites zitteli* MOJSISOVICS, 1882 — VÖRÖS, Preliminary results from Aszófő, p. 56, pl. I, figs. 4a–b.

v 1987 *Balatonites* cf. *pragsensis* (LORETZ, 1875) — VÖRÖS, Preliminary results from Aszófő, p. 56.

Material: 29 specimens of variable state of preservation, partly with silicified shells; 28 from Aszófő, 1 from Veszprém ("Szabadság-puszta").

Dimensions:

D	WH	WW	U
66.7	23.0	>8.0	20.4
65.2	26.0	>11.0	22.0
50.1	17.5	>10.0	18.3
42.2	16.3	>7.0	14.6
34.0	14.4	>7.0	10.2
28.3	11.0	6.0	10.0
25.2	10.0	5.5	8.4
24.6	9.5	5.8	8.5

Description: Medium-sized *Balatonites*. The conch is strongly compressed, the coiling is moderately evolute. The whorl-section is high oval. The umbilical wall is rather steep but becomes subrounded on the body chamber. The flanks are very slightly convex, nearly flat. The venter is sharply fastigate but becomes blunt on the body chamber. The ornamentation consists of weak, prorsiradiate ribs and fine but marked tubercles. The ribbing is rather regular; bifurcation is rare; secondary ribs are inserted usually in the outer third of the flank, rarely the secondary ribs start at the inner third. Fine riblets appear irregularly on the body chamber. The primary ribs continue on the venter in the form of a weak chevron pattern. The tubercles are arranged into regular spiral rows. Three rows, an umbilical, a lateral, and a ventrolateral, develop on the flanks, and another row on the ventral keel. The lateral row of tubercles runs at the middle of the flank; the tubercles are regularly spaced and form a very prominent spiral on the almost smooth flank.

Suture lines are not visible.

Remarks: In a recent morphometric study of *Balatonites* populations, HOHENEGGER & TATZREITER (1992) grouped the majority of the previously described nominal *Balatonites* species into two, variable species: *B. balatonicus* and *B. egregius*. The *Balatonites* population of the Aszófő section, including the especially weakly ornamented group described here, should belong to *B. balatonicus*. Nevertheless, it was felt reasonable to distinguish and describe this group as a morphotype *zitteli* within the species *B. balatonicus*. The name does not necessary implies a specific identity with *B. zitteli* MOJSISOVICS though the morhological similarity is obvious.

The smaller specimen figured by MOJSISOVICS (1882, pl. XIX, figs. 3a–b) probaly does not belong to *Balatonites*. The original was not found in the museum of the GIH (Budapest), but new collections at the locality Nagyvázsony (now Vöröstó, Akol-domb) restricted the age of those strata to the Late Illyrian (VÖRÖS 1998, p. 49).

LÓCZY's record (1916, l. c.: *B. lineatus,* Hidegkút) from the Balaton Highland was revised in the collections of the GIH (Budapest); the specimen (inventory number T.2171) seems to belong to the morphotype *zitteli*.

This morphotype is represented in the rich *Balatonites* collection of the Natural History Museum (London). The material, purchased from V. Havelka and regrettably not registered by SPATH (1934), came from Han Bulog-type limestones from Mali Durmitor (Montenegro) and Stavljan,Volujak (Bosnia).

Distribution: *B. balatonicus* morphotype *zitteli* is frequent in the Balaton Highland; in the Aszófő section it ranges through the Balatonicus and Cadoricus Subzones. It was found in the Anisian of the Dinarides and may be present in the Northern Calcareous Alps.

***Balatonites gemmatus* MOJSISOVICS, 1882**

Plate A-V, 4, 5, 6a–b.

v * 1882 *Balatonites gemmatus* E. v. MOJSISOVICS — MOJSISOVICS, Ceph. mediterr. Triasprovinz, p. 81, pl. VI, figs. 3a–b.
v ? 1903 *Balatonites* cfr. *transfuga* ARTH. — ARTHABER, Neue Funde im Muschelkalk des südlichen Bakony, p. 12.
v 1991 *Balatonites* cf. *gemmatus* MOJSISOVICS, 1882 — TATZREITER & VÖRÖS, Vergleich der pelsonischen..., p. 253.
v 1998 *Balatonites* cf. *gemmatus* (MOJSISOVICS) — VÖRÖS, A Balatonfelvidék triász ammonoideái, p. 74, pl. I, fig. 1.

Material: Seven specimens of variable state of preservation; 6 from Aszófő, 1 from Veszprém ("Szabadság-puszta").

Dimensions:

D	WH	WW	U
52.0	21.4	11.6	19.5
40.4	16.3	?	14.0

Description: Medium-sized *Balatonites* with compressed whorls and moderately evolute coiling. The whorl-section is high oval to subpentagonal. The umbilical wall is rather steep. The flanks are gently convex. The venter is highly fastigate even on the body chamber. The ornamentation consists of moderately strong, projected ribs and equally strong tubercles. The ribbing is rather dense; secondary ribs are inserted at various distances from the umbilical margin. The ribs are projected at the venter forming a chevron-like pattern. All ribs (primaries and secondaries) carry distinct tubercles of nearly equal strength. The tubercles are arranged into 6–7 spiral rows on the flanks of the body chamber. In some cases this interaction between ribbing and tuberculation produces a trachyceratid-like ornamentation (*e.g.* Plate A-V, 4). The elevated row of gently elongated ventral tubercles form a distinct serrate keel.

Suture lines are not visible.

Remarks: By its trachyceratid-like ornamentation, *B. gemmatus* is an exceptionally distinct species within its genus. From among the possibly related forms, *B. transfuga* ARTHABER, 1896 is much more compressed and possesses a finer and denser ornamentation. The ornamentation of the flanks of *B. margaritatus* FRECH, 1903 is also somewhat similar to *B. gemmatus*, but the robust body chamber with almost flat venter makes strong difference. The provenance of type specimen of *B. margaritatus* is at least doubtful. It is kept in the collections (The Geological Museum of Hungary) of the Geological Institute of Hungary (GIH, Budapest) under the inventory number T.834. and, according to FRECH (1903), was collected from Felsőörs, from the Reitzi Zone. If it is true, the specimen must be a derived fossil from the deep underlying Balatonicus Zone (Pelsonian). The little rock material attached to the specimen does not give decisive evidence but seems to differ from the usually grey, bituminous Pelsonian limestones of the surrounding region. Alternatively, we may suppose that this single specimen came from some quite distant locality and was mixed accidentally to other ammonites of the Reitzi Zone from Felsőörs in the museum collections.

ARTHABER's record (1903, l. c.: *B.* cfr. *transfuga,* Balatonfüred) from the Balaton Highland was revised in the collections of the GIH (Budapest); the specimen (inventory number T.2344) probably belongs to *B. gemmatus*.

Distribution: *B. gemmatus* was described from the Anisian Schreyeralm Limestone of the Northern Calcareous Alps. At the Balaton Highland it was found in two localities; in the Aszófő section its range is restricted to the Balatonicus Subzone.

Balatonites egregius* ARTHABER, 1896, morphotype *jovis

Plate A-V, 7a–b, 8, 9, 10, 11.

v 1873 *Trachyceras Balatonicum* E. v. MOJSISOVICS . — MOJSISOVICS, Über einige Trias-Versteinerungen, p. 426 (partim), pl. XIII, figs. 4a–b, (non figs. 3a–b).

v 1882 *Balatonites balatonicus* E. v. MOJSISOVICS — MOJSISOVICS, Ceph. mediterr. Triasprovinz, p. 78 (partim), pl. IV, (figs. 3a–b, only).

v * 1896 *Balatonites Jovis* ARTH. — ARTHABER, Cephalopod. Reiflinger Kalke (II), p. 212, pl. XII, figs. 4a–c.

1896 *Balatonites Doris* ARTH. — ARTHABER, Cephalopod. Reiflinger Kalke (II), p. 213, pl. XII, figs. 5a–c.

v 1896 *Balatonites Peleus* ARTH. — ARTHABER, Cephalopod. Reiflinger Kalke (II), p. 219, pl. XIII, figs. 5a–c.

v ? 1896 *Balatonites Haueri* ARTH. — ARTHABER, Cephalopod. Reiflinger Kalke (II), p. 211, pl. XII, figs. 3a–c.

? 1915 *Balatonites constrictus* v. ARTH. — RASSMUSS, Alpine Cephalopoden im niederschlesischen Muschelkalk, p. 300, pl. 2, figs. 3, 4.

v ? 1916 *Balatonites* cf. *lineatus* ARTH. — LÓCZY, Die geologischen Formationen der Balatongegend, p.115.

? 1980 *Balatonites balatonicus* (MOJSISOVICS) — GU *et al.*, Late Anisian from Doilungdeqen, p. 353, pl. II, figs. 26, 27, text-fig. 7.

? 1986 *Balatonites* sp. cf. *Balatonites jovis* ARTHABER, 1896 — PARNES, Triassic cephalopods from the Negev, p. 26, pl. 4, figs. 10–12.

v 1987 *Balatonites jovis* ARTHABER, 1896 — VÖRÖS, Preliminary results from Aszófő, p. 56, pl. I, figs. 3a–b.

v 1991 *Balatonites egregius* ARTHABER, 1896 (= *B. jovis* Art.) — TATZREITER & VÖRÖS, Vergleich der pelsonischen..., p. 253, pl. 1, fig. 8.

v 1992 *Balatonites egregius* ARTHABER, 1896 — HOHENEGGER & TATZREITER, Morphometric methods, p. 811 (partim), figs. 18/14–15, 19/14–15.

1999 *Balatonites jovis* ARTHABER, 1896 — KAIM & NIEDŹWIEDZKI, Middle Triassic ammonoids from Silesia, p. 109, figs. 10D, 11C.

Material: 28 specimens of variable state of preservation; 24 from Aszófő, 3 from Mencshely (Cser-tető III) and 1 from the surroundings of Felsőörs.

Dimensions:

D	WH	WW	U
88.8	31.7	14.3	34.5
53.0	20.3	>10.0	18.0
51.7	19.7	>9.0	19.0
44.6	17.3	>9.0	15.0

Description: Medium-sized *Balatonites* with strongly compressed conch and moderately evolute coiling. The whorl-section is high oval. The umbilical wall is rather steep. The flanks are very slightly convex. The venter is fastigate but becomes blunt on the body chamber. The ornamentation consists of very dense, weak, markedly prorsiradiate ribs and fine tubercles. The ribbing is rather irregular; bifurcation is rare; insertion of secondary ribs may start either at the umbilical shoulder or near the ventrolateral margin. Fine riblets appear irregularly on the body chamber. The ribs continue on the venter in the form of a weak chevron pattern. The umbilical, lateral and ventrolateral tubercles are arranged into regular spiral rows. An additional row of fine tubercles may appear in the inner (umbilical) half of the flank on the body chamber. The ventral keel bears a weak row of tubercles.

Suture lines are not visible.

Remarks: In a recent morphometric study of *Balatonites* populations, HOHENEGGER & TATZREITER (1992) grouped the majority of the previously described nominal *Balatonites* species into two, variable biological species: *B. balatonicus* and *B. egregius*. The nominal species *B. jovis* ARTHABER, 1896 was ranged into *B. egregius*, the indigenous biospecies of the Rahnbauerkogel fauna. However, it was stated also, that some specimens of the deeper stratigraphic horizons of the Aszófő fauna belong to *B. egregius*, and one specimen from Aszófő, previously called *B. jovis* by VÖRÖS (1987), was figured under the name *B. egregius* (HOHENEGGER & TATZREITER, l. c. figs. 19/14–15). On this basis, it was felt reasonable to distinguish and describe this group as a morphotype *jovis* within the species *B. egregius,* by the most apparent distinctive characters of the weak, dense, prorsiradiate ribbing and the weak tuberculation.

This morphotype was represented in the original type series of *B. balatonicus* in MOJSISOVICS (1873, 1882, l. c.) as a distinctly different, densely and weakly ribbed form (kept in the collections of the GIH, Budapest, under the inventory number T.145.).

Some of the variable *Balatonites* specimens found in the Germanic Lower Muschelkalk (*e.g.* the records in the above synonymy by RASSMUSS, l. c. and KAIM & NIEDŹWIEDZKI, l. c.) probably belong to "*jovis*", based on the charcter of their ornamentation. The same holds true for the records by GU *et al.* 1980, l. c., under the name *B. balatonicus*) and by LÓCZY (1916, l. c., under the name *B.* cf. *lineatus*, kept in the collections of the GIH, Budapest, under the inventory number T.139.).

The *Balatonites* specimen figured by PARNES (1986, l. c.) is very poorly preserved for allowing a definite attribution to this taxon.

Distribution: This morphotype is known from the Northern Calcareous Alps and the Balaton Highland to the Germanic Basin, where it seems to be confined to the deepest part of the Pelsonian or to the uppermost Bithynian. It would be very widespread, if its occurrence in Israel and Tibet is confirmed. At the Balaton Highland it was found in three localities; in the Aszófő and Mencshely sections it ranges from the Ottonis to the Balatonicus Subzone.

Genus **Bulogites** ARTHABER, 1912

Bulogites zoldianus **(MOJSISOVICS, 1882)**

Plate A-VI, 1a–c; Figure A-17.

1851 *A. (Ceratites) binodosus* n. sp. — HAUER, Venetianer Alpen gesammelten fossilien, p. 114 (partim), pl. XIX, figs. 3a–b. non figs. 1, 3, 4).
v * 1882 *Ceratites zoldianus* E. v. MOJSISOVICS — MOJSISOVICS, Ceph. mediterr. Triasprovinz, p. 39, pl. X, figs. 5, 6a–b.
v ? 1916 *Ceratites* sp. ex aff. *Zoldianus* MOJS. — LÓCZY, Die geologischen Formationen der Balatongegend, p. 114.
? 1926 *Ceratites zoldianus* E. v. MOJSISOVICS — ASSMANN, Wirbellosen der oberschlesischen Trias, p. 526 (partim), pl. 9, figs. 5a–b. non fig. 6)
? 1937 *Ceratites zoldianus* E. v. MOJS. — ASSMANN, Revision der Fauna oberschlesischen Trias, p. 104 (partim), pl. 22, figs. 2a–b. non fig. 3)
1963 *Bulogites zoldianus* (MOJSISOVICS) 1882. — ASSERETO, Anisico della Val Camonica, p. 61 (partim), fig. 22 (?), pl. VI, fig. 3, (non ? figs. 4, 5, 6).
1969 *Bulogites* aff. *zoldianus* (MOJSISOVICS, 1882) — GAETANI, Anisico Giudicarie, p. 519, pl. 36, figs. 8a–b, 9, 10.
? 1986 *Bulogites* ex gr. *zoldianus* (MOJSISOVICS, 1882) — RAKÚS, Ammonites of Reifling Limestones, p. 82, pl. 1, fig. 6, text-fig. 9.
v 1987 *Bulogites zoldianus* (MOJSISOVICS, 1882) — VÖRÖS, Preliminary results from Aszófő, p. 55, pl. III, figs. 1a–b.
v 1991 *Bulogites zoldianus* (MOJSISOVICS, 1882) — TATZREITER & VÖRÖS, Vergleich der pelsonischen..., p. 253, pl. 2, fig. 1.

Material: Nine incomplete specimens from Aszófő.

Dimensions:

D	WH	WW	U
>64.0	28.0	17.5	19.0
? 25.0	19.0	?	

Description: The specimens (moulds of body chambers) are medium-sized for the genus. The whorls are moderately compressed; the cross-section is subquadratic. The umbilical wall is steep and smooth; the umbilical edge is subrounded. The flanks are flat to gently convex and forms a rather well marked ventrolateral shoulder with the flat, gently arched venter. The flanks are ornamented with moderately strong ribs and nodes. The prorsiradiate ribs are gently sinuous; their number increases by bifurcation and insertion at around the mid-flank. In the ventral third of the flank the ribs show their maximum strength, then somewhat weaken near the ventrolateral margin. There are three, an umbilical, a lateral and a ventrolateral, rows of nodes on the flank. The umbilical nodes are weak and fade out on the body chamber. The lateral nodes are the sites of occasional bifurcation of ribs at around the one-third of the flank. The ventrolateral nodes are the strongest; they are gently elongated, in the form of clavi.

Suture lines are not visible.

Remarks: MOJSISOVICS (1882, l. c.) based his new species *zoldianus* on a figure by HAUER (1851, pl. XIX, figs. 3a–b) so separating this characteristically ornamented body chamber from HAUER's extremely widely interpreted type series of "*C. binodosus*".

LÓCZY's record (1916, l. c.) from the Balaton Highland (Hidegkút) was revised in the collections of the GIH (Budapest); the specimen (inventory number T.2170) seems to belong to *B. zoldianus*.

One of ASSMANN's figured specimens (1926, pl. 9, figs. 5a–b) may belong to *B. zoldianus* after its characteristic ribbing and cross-section, whereas the other (fig. 6) shows very different ornamentation. The same specimens were figured again by ASSMANN (1937, l. c.) and the above remarks hold true for them.

ASSERETO (1963, l. c., pl. VI, fig. 3.) re-figured the holotype of *B. zoldianus*. His other three figured specimens probably belong to different species. The specimens figured by RAKÚS (1986, l. c.) are very poorly preserved showing only vague ornamentation but the cross-section seems definitive.

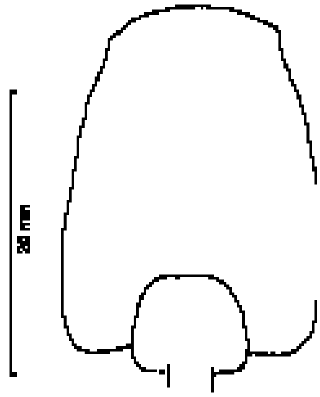

Figure A-17. Cross section of *Bulogites zoldianus* (MOJSISOVICS, 1882), (2003.87.1.), Aszófő I, Bed 79, Balatonicus Zone, Zoldianus Subzone

Distribution: *B. zoldianus* was described from the Anisian of the Southern Alps, later it was found at the Balaton Highland, in the West Carpathians and probably in the Muschelkalk of the Germanic facies area. At the Balaton Highland it was found in the Aszófő section where its range is restricted to the higher part of the Zoldianus Subzone.

Bulogites gosaviensis **(MOJSISOVICS, 1882)**

Plate A-VI, 2; Figure A-18.

v * 1882 *Ceratites gosaviensis* E. v. MOJSISOVICS — MOJSISOVICS, Ceph. mediterr. Triasprovinz, p. 39, pl. X, figs. 8a–b.

? 1905 *Ceratites gosaviensis* MOJS. — AIRAGHI, Ammoniti triasici del M. Rite in Cadore, p. 242, pl. VIII, fig. 3.

v ? 1916 *Ceratites* cf. *gosaviensis* MOJS. — LÓCZY, Die geologischen Formationen der Balatongegend, p. 110.

1963 *Bulogites gosaviensis gosaviensis* (MOJSISOVICS) 1882. — ASSERETO, Anisico della Val Camonica, p. 50, fig. 17, pl. III, figs. 6a–d, 7a–b.

v non 1973 *Bulogites*? cf. *gosaviensis* (MOJS., 1882) — RIEBER, Cephalopoden aus der Grenzbitumenzone, p. 62, fig. 13r, pl. 16, figs. 4, 5, 6.

? 1980 *Reiflingites* cf. *gosaviensis* (MOJSISOVICS) — GU *et al.*, Late Anisian from Doilungdeqen, p. 353, pl. II, figs. 20, 21.

v 1987 *Bulogites* cf. *gosaviensis* (MOJSISOVICS, 1882) — VÖRÖS, Preliminary results from Aszófő, p. 55, pl. III, figs. 3, 4.

v 1991 *Bulogites* cf. *gosaviensis* (MOJSISOVICS, 1882) — TATZREITER & VÖRÖS, Vergleich der pelsonischen..., p. 253, pl. 2, fig. 7.

v 1991 *Bulogites* cf. *gosaviensis* (MOJSISOVICS, 1882). — TATZREITER & VÖRÖS, Vergleich der pelsonischen..., p. 258, pl. 3, fig. 3.

Material: Five incomplete specimens from Aszófő.

Dimensions: None of the specimens was suitable for measuring.

Description: Small to medium-sized *Bulogites*. The features of coiling and whorl-section are only partly seen. The flanks are gently convex. The ventrolateral shoulder is well-marked. The venter is moderately narrow, rather arched. The flanks are ornamented with nodes and with strong, rectiradiate ribs, slightly projected near the ventrolateral margin. Secondary ribs are inserted at around the mid-flank; bifurcation was not observed. The ribs pass the ventrolateral margin, become very weak and strongly projected on the venter and vanish rapidly. The umbilical nodes are weak. Lateral nodes hardly develop. The ventrolateral nodes are markedly oblique forward.

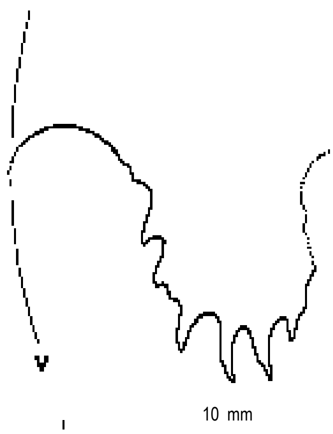

Figure A-18. Suture line of *Bulogites gosaviensis* (MOJSISOVICS, 1882), (2003.86.1.), Aszófő I, Bed 59, Balatonicus Zone, Zoldianus Subzone
v: ventrolateral shoulder

Suture lines are only partially visible. The large and deep lateral lobe is deeply indented; the first lateral saddle is incised almost up to the top.

Remarks: MOJSISOVICS (1882, l. c.) when describing *B. gosaviensis*, gave (among others) the arching of the venter as distinctive difference from *B. zoldianus*. This, and the character of the ribbing (radial, with inserted secondaries in contrast to prorsiradiate with frequent bifurcations in *B. zoldianus*) are used here as distinctive features.

LÓCZY's record (1916, l. c.) from the Balaton Highland (Balatonfüred, Tamáshegy) was revised in the collections of the GIH (Budapest); the specimen (inventory number T.2301) is a strongly ribbed body chamber fragment of a *Bulogites*.

The specimen figured by AIRAGHI (1905, l. c.) is very poorly preserved, therefore its attribution to *B. gosaviensis* is taken here as doubtful.

One of the specimens figured by RIEBER (1973, pl. 16, figs. 4, 5) shows a ribbing similar to *B. gosaviensis*, but its high stratigraphic position (Secedensis Zone ?) excludes it from *Bulogites*; it probably belongs to *Ticinites*.

Distribution: *B. gosaviensis* was described from the Anisian Schreyeralm Limestone of the Northern Calcareous Alps. Later on the species was found in other Anisian localities of the Northern Calcareous Alps, the Southern Alps and possibly also in Tibet. At the Balaton Highland it was collected only in the Aszófő section, where its range is restricted to the lower part of the Zoldianus Subzone.

***Bulogites multinodosus* (HAUER, 1892)**

Plate A-VI, 3, 4.

v * 1892 *Ceratites multinodosus* n. sp. — HAUER, Neue Funde aus dem Muschelkalk von Han Bulog, p. 260, pl. III, figs. 1a–c.
1905 *Ceratites multinodosus* HAUER. — AIRAGHI, Ammoniti triasici del M. Rite in Cadore, p. 247, pl. VIII, fig. 7.
v 1934 *Bulogites multinodosus* (HAUER) — SPATH, Catalogue British Museum, Trias, p. 461.
v 1987 *Bulogites* cf. *multinodosus* (HAUER, 1892) — VÖRÖS, Preliminary results from Aszófő, p. 55.
v 1991 *Bulogites* cf. *multinodosus* (HAUER, 1892) — TATZREITER & VÖRÖS, Vergleich der pelsonischen..., p. 253.

Material: Two incomplete specimens (fragments of body chambers with remnants of phragmocone) from Aszófő.

Dimensions: None of the specimens was suitable for measuring.

Description: Large-sized *Bulogites*. The features of coiling and whorl-section are only partly seen. The umbilical wall is steep. The flanks are gently convex; the maximum width lies in the inner one-third of the flank. The ventrolateral margin is subrounded. The venter is rather highly arched. The ornamentation consists of strong ribs bearing nodes. The ribs are rectiradiate to prorsiradiate and become gently projected ventrally. Secondary ribs are inserted at around the mid-flank; bifurcation was not observed. The ribs reach the venter where they are strongly projected adorally and disappear shortly. The umbilical nodes are rather bullae. The lateral nodes, at the inner third of the flank, are strong. The ventrolateral nodes are very marked and oblique forward. The outer (ventral) third of the ribs (including secondaries) inflates with a tendency to the development of a fourth, indistinct row of nodes.

Suture lines were not seen.

Remarks: *B. multinodosus* is perhaps the largest species of the genus *Bulogites*. It stands close to *B. gosaviensis* but the presence of strong lateral nodes and especially the development of a fourth lateral spiral of nodes on the secondary ribs as well, seem to distinctly differentiate it from the latter. The holotype was examined in the Naturhistorisches Museum, Vienna. The suture drawing (HAUER l. c., pl. III, fig. 1c) was taken from another specimen.

Distribution: *B. multinodosus* was described from the Anisian Han Bulog limestones of the Dinarides, later it was found in the Southern Alps and the Balaton Highland. Here it was collected only in the Aszófő section, where its range is restricted to the lower part of the Zoldianus Subzone.

***Bulogites mojsvari* (ARTHABER, 1896)**

Plate A-VI, 5, 6a–c, 7, 8; Figure A-19.

v * 1896 *Ceratites Mojsvari* ART. — ARTHABER, Cephalopod. Reiflinger Kalke (I), p. 50, pl. IV, figs. 6a–d.
v 1896 *Ceratites Reiflingensis* ART. — ARTHABER, Cephalopod. Reiflinger Kalke (I), p. 56, pl. V, figs. 3a–c, 5a–c.
1963 *Bulogites reiflingensis reiflingensis* (ARTHABER) 1896. — ASSERETO, Anisico della Val Camonica, p. 54, fig. 19, pl. V, figs. 1, 2a–b, 3a–b, 4, 5.
v 1987 *Bulogites reiflingensis* (ARTHABER, 1896) — VÖRÖS, Preliminary results from Aszófő, p. 55, pl. III, figs. 2a–b.
v 1991 *Bulogites mojsvari* (ARTHABER, 1896) — TATZREITER & VÖRÖS, Vergleich der pelsonischen..., p. 253, pl. 2, fig. 8.
v 1991 *Bulogites mojsvari* (ARTHABER, 1896). — TATZREITER & VÖRÖS, Vergleich der pelsonischen..., p. 256, 257, pl. 2, figs. 9a–b, pl. 3, fig. 2.
? 1992 *Bulogites* cf. *B. mojsvari* (ARTHABER) — BUCHER, Ammonoids of the Shoshonensis Zone, p. 437, text-figs. 17, 18.

Material: Nine specimens of variable state of preservation, some of them completely silicified; 7 from Aszófő, 2 from Mencshely (Cser-tető III).

Dimensions:

D	WH	WW	U
59.7	26.8	18.5	15.0
52.0	24.0	16.5	13.8

Description: Medium to large-sized *Bulogites* with moderately involute conch. The whorl-section is high oval to subquadrate. The umbilical wall is vertical to overhanging. The flanks are gently convex. The ventrolateral margin is well-marked; the venter is arched. The flanks are ornamented with nodes sitting on strong, rectiradiate ribs, becoming gently sinuous on the body chamber. Secondary ribs are inserted at around the mid-flank; bifurcation rarely occurs. The ribs show their maximum strength in the ventral third of the flank, then somewhat weaken near the ventrolateral margin and vanish on the edge of the venter. The umbilical nodes are of medium strength. The lateral nodes, on the inner third of the ribs, are very pronounced and high, but not pointed. The ventrolateral nodes are marked, slightly clavate.

Suture lines are not visible.

Remarks: *B. mojsvari* was described by ARTHABER (1896, l. c.) from the Tiefengraben fauna, together with some other *Bulogites*, from which *B. reiflingensis* shows strong similarity to it. This regards especially the ornamentation; the only difference is in the height/width ratio of the whorls (though this is much exaggerated in ARTHABER's figures). After all, these two forms are considered as conspecific (an opinion shared with F. TATZREITER, pers. comm.) and the species name *B. mojsvari* is used here by page priority.

B. mojsvari belongs to a morphogroup of *Bulogites* together with *B. gosaviensis* (MOJSISOVICS) and *B. multinodosus* (HAUER), where its most important distinctive character is considered to be the very prominent lateral row of nodes.

The specimen figured by BUCHER (1992, l. c.) stands close to *B. mojsvari* but, perhaps due to its preservation, its lateral row of nodes does not seem very prominent.

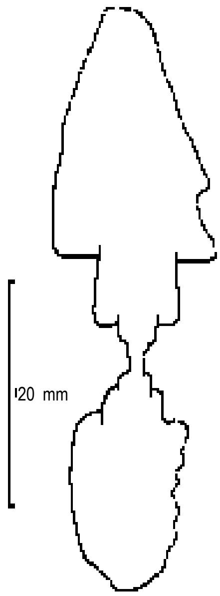

Figure A-19. Cross section of *Bulogites mojsvari* (ARTHABER, 1896), (2003.85.1.), Aszófő I, Bed 61, Balatonicus Zone, Zoldianus Subzone

Distribution: *B. mojsvari* was desribed from from the Middle Anisian Gutenstein Limestone of the Northern Calcareous Alps. Later on the species (including its synonyms) was found in the Anisian of the Southern Alps and even from Nevada. At the Balaton Highland it was collected from the Aszófő and the Mencshely sections where its range is restricted to the Zoldianus Subzone.

Family Ceratitidae MOJSISOVICS, 1879
Subfamily Beyrichitinae, SPATH, 1934

Genus **Beyrichites** WAAGEN, 1895

Beyrichites cadoricus **(MOJSISOVICS, 1869)**

Plate A-VII, 6, 7, 8, 9; Figures A-20, A-21, A-22.

1851 *A. (Ceratites) binodosus* n. sp. — HAUER, Venetianer Alpen gesammelten fossilien, p. 114 (partim), pl. XIX, figs. 2a–c, 4 (?) (non figs. 1, 3).
* 1869 *Ammonites Cadoricus* MOJS. nov. sp. — MOJSISOVICS, Cephalopoden-Fauna des alpinen Muschelkalkes, p. 583.
v 1882 M*eekoceras cadoricum* E. v. MOJSISOVICS — MOJSISOVICS, Ceph. mediterr. Triasprovinz, p. 215, pl. XII, figs. 9a–c.
1969 *Beyrichites (Beyrichites) cadoricus* (MOJSISOVICS, 1869) — GAETANI, Anisico Giudicarie, p. 521, pl. 37, figs. 2a–b, 3a–b, 4, 5, text-fig. 12.
1976 *Beyrichites* cf. *cadoricus* (MOJS.) — WANG & HE, Triassic ammonoids from the Mount Jolmo Lungma, p. 300, fig. 18c, pl. 8, figs. 1, 2, 3, 4, 11, 12, (? pl. 16, figs. 4, 5, 6).
? non 1986 *Beyrichites* cf. *cadoricus* (MOJSISOVICS) — HE *et al.*, Triassic cephalopods of Mt. Burhan Budai, p. 220, pl. 7, figs. 5, 6, 12, 13.
v 1987 *Beyrichites cadoricus* (MOJSISOVICS, 1869) — VÖRÖS, Preliminary results from Aszófő, p. 55, pl. II, figs. 1a–b.
v 1991 *Beyrichites cadoricus* (MOJSISOVICS, 1869) — TATZREITER & VÖRÖS, Vergleich der pelsonischen..., p. 253.

Material: 35 specimens of variable state of preservation, partly with silicified shells; all from Aszófő.

Dimensions:

D	WH	WW	U
50.3	28.6	14.5	5.3
35.5	19.5	10.3	4.5
32.0	17.2	9.2	?5.2
26.0	13.0	8.5	4.0
22.7	11.7	7.0	?4.0
22.0	11.5	>5.0	4.0

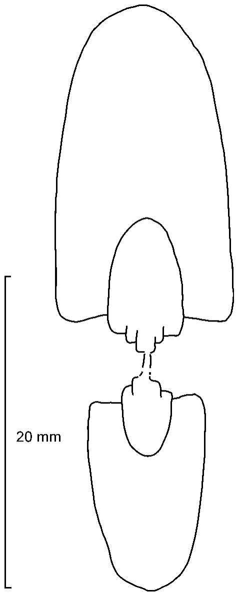

Figure A-20. Cross section of *Beyrichites cadoricus* (MOJSISOVICS, 1869), (2003.82.1.), Aszófő I, Bed 12, Balatonicus Zone, Cadoricus Subzone

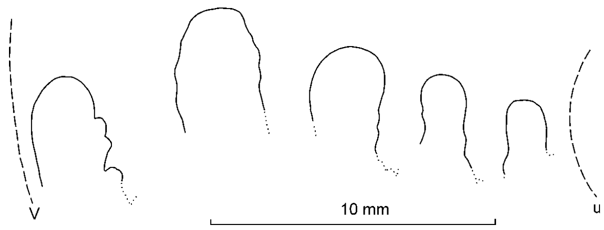

Figure A-21. Suture line of *Beyrichites cadoricus* (MOJSISOVICS, 1869), (2003.90.1.), Aszófő I, Bed 15, Balatonicus Zone, Cadoricus Subzone
u = umbilical margin, v = ventrolateral margin

Figure A-22. Suture line of *Beyrichites cadoricus* (MOJSISOVICS, 1869), (2003.93.1.), Aszófő I, Bed 14, Balatonicus Zone, Cadoricus Subzone
u = umbilical margin, v = ventrolateral margin

Description: Medium-sized *Beyrichites* with involute coiling. The whorl-section is high oval to subtrigonal. The umbilical wall is steep, slightly overhanging; the umbilical shoulder is very pronounced. The flanks are flat, subparallel and pass gradually into the highly arched venter. Ventrolateral rim or fastigation are barely seen. The flanks are ornamented with very weak, rectiradiate, blunt ribs becoming projected ventrally and vanishing rather abruptly at the venter. The ribbing may be irregularly weak or slightly sinuous on the body chamber.

Suture lines were only partially visible. Besides the deep lateral lobe, there are at least three umbilical elements. The saddles, especially the first and second lateral, are incised nearly to their top.

Remarks: MOJSISOVICS (1869, l. c.) based his new species *cadoricus* on a figure by HAUER (1851, pl. XIX, figs. 2a–c) portraying a small, smooth ammonite of Hauer's extremely widely interpreted type series of "*C. binodosus*". Despite that the figure does not show the characteristic ribbing of the species, it must be taken as the first illustration of *B. cadoricus*. HAUER's other figure (l. c. pl. XIX, fig. 4) shows a cross-section apparently typical for this species. WANG & HE (1976, l. c.) figured specimens showing, at least partly, the characteristic features of *B. cadoricus.* The figures published by HE *et al.* 1986, l. c.) does not seem to support their specimens' assignment to this species.

B. cadoricus can be separated from the closely related *B. beneckei* and *B. reuttensis*. *B. beneckei* has invariably sinuous ribs with projected clavi on their ventral end; in *B. reuttensis* the weak primary ribs are more widely spaced and there are flaring secondaries in the interspaces.

Distribution: *B. cadoricus* was described from diverse localities of the Anisian of the Southern Alps and the Himalaya region; the occurrence in Central Asia (Kun Lun) is ambiguous. At the Balaton Highland it was collected from the Aszófő section where its range is restricted to the Cadoricus Subzone.

Beyrichites beneckei **(MOJSISOVICS, 1882)**

Plate A-VII, 4, 5a–b; Figure A-23.

v * 1882 *Meekoceras Beneckei* E. v. MOJSISOVICS — MOJSISOVICS, Ceph. mediterr. Triasprovinz, p. 216, pl. XXVIII, fig. 1, pl. XXXIX, fig. 6, pl. LXI, figs. 2a–b, 3a–b. ? fig. 4.)
1898 *Ceratites Beneckei* v. MOJSISOVICS sp. — TORNQUIST, Umgebung von Recoaro und Schio, p. 643, pl. XX, fig. 2.
? 1901 cf. *Beyrichites Beneckei* Mojs. spec. — REIS, Eine Fauna des Wettersteinkalkes, p. 99, pl. VII, fig. 34.
? 1963 *Beyrichites* (*Beyrichites*) cf. *beneckei* (MOJSISOVICS) 1882. — ASSERETO, Anisico della Val Camonica, p. 29, fig. 7, pl. I, fig. 8.
1968 *Beyrichites* (*Beyrichites*) *beneckei* (MOJS.) — VENZO & PELOSIO, Anisico superiore di Lenna, p. 93, pl. VII, figs. 2a–d, 3a–b, 4, 5a–c, 12a–b.
? 1976 *Beyrichites* cf. *beneckei* (MOJS.) — WANG & HE, Triassic ammonoids from the Mount Jolmo Lungma, p. 299, fig. 18b, pl. 8, figs. 8, 9, 10.
v 1987 *Beyrichites beneckei* (MOJSISOVICS, 1881) — VÖRÖS, Preliminary results from Aszófő, p. 55.
v 2002 *Beyrichites* cf. *beneckei* (MOJSISOVICS, 1881) — VÖRÖS & PÁLFY, The Pelsonian at Köveskál, p. 55. pl. I, fig. 6.

Material: 37 specimens of variable state of preservation; 32 from Aszófő, 5 from Köveskál (Horog-hegy).
Dimensions:

D	WH	WW	U
68.2	36.4	16.7	10.0
38.6	21.3	12.0	5.0
29.0	15.5	8.0	4.7
23.8	12.1	>5.5	4.5

Description: Medium to large-sized *Beyrichites* with rather involute coiling. The whorl-section is high oval, with maximum width at around mid-whorl. The umbilical wall is steep; the umbilical shoulder is subrounded. The flanks are moderately convex and pass gradually into the highly arched venter. The ornamentation consists of sinuous radial ribs which strengthen ventrally and bear flat but distinct, projected clavi at their ventrolateral end.

Suture lines were not seen.

Remarks: *B. beneckei* differs from other species of *Beyrichites* by the distinct ventrolateral row of adorally projected clavi. One of the specimens figured by MOJSISOVICS (1882, pl. LXI, fig. 4) bears strong ribs on its flank, therefore it probably does not belong to this species.

The specimen figured by TORNQUIST (1898, l. c.) seems to be a very typical *B. beneckei*. REIS (1901, l. c.) figured only a cross-section but it appears to be very similar to that of this species. ASSERETO's figures (1963, l. c.) are not informative enough to support a definite attribution to the species in question. The specimens figured by VENZO & PELOSIO (1968, l. c.) show the characteristic ornamentation regarded here as typical for *B. beneckei*. The single figured cross-section (l. c. fig. 2b) also fits well, though the ventral views of the other specimens suggest a slightly tabulate venter. The figures published by WANG & HE (1976, l. c.) are not really convincing about the species attribution.

Distribution: *B. beneckei* was described and repeatedly recorded from the Anisian of the Southern Alps. Later on it was found in the Wetterstein Limestone of the Northern Calcareous Alps and, doubtfully, in the Himalaya region. At the Balaton Highland it was collected in the Aszófő and the Köveskál (Horog-hegy) sections, where it ranges from the Cadoricus Subzone to the Binodosus Subzone.

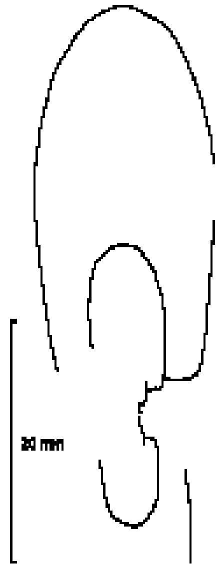

Figure A-23. Cross section of *Beyrichites beneckei* (MOJSISOVICS, 1882), (2003.80.1.), Aszófő I, Bed 88, Balatonicus Zone, Zoldianus Subzone

***Beyrichites* cf. *reuttensis* (BEYRICH, 1867)**

Plate A-VII, 10.

* 1867 *Ammonites Reuttensis.* — BEYRICH, Über einige Cephalopoden, p. 113, pl. I, figs. 4a–c.
1882 *Meekoceras reuttense* (BEYRICH) E. v. M. — MOJSISOVICS, Ceph. mediterr. Triasprovinz, p. 215, pl. IX, figs. 1a–b, 2a–c, 3a–b.
? 1901 *Beyrichites Reuttensis* BEYR. (spec. var. ?) — REIS, Eine Fauna des Wettersteinkalkes, p. 99, pl. VII, fig. 33.
? 1904 *Meekoceras reuttense* BEYRICH sp. 1867. — MARTELLI, Boljevici presso Vir nel Montenegro, p. 88, pl. VI, fig. 2.
? 1907 *Beyrichites Reuttensis* BEYR. spec. — REIS, Eine Fauna des Wettersteinkalkes, Nachtrag, p. 134, pl. II, figs. 9, 9a, pl. III, figs. 1, 1a, text-fig. 11.
1963 *Beyrichites (Beyrichites) reuttensis* (BEYRICH) 1867. — ASSERETO, Anisico della Val Camonica, p. 31, fig. 8, pl. II, figs. 2a–c.
1968 *Beyrichites (Beyrichites)* cfr. *reuttensis* (BEYRICH) — VENZO & PELOSIO, Anisico superiore di Lenna, p. 92, pl. VII, figs. 1a–d.
1968 *Beyrichites (Beyrichites) reuttensis* (BEYRICH) — SHEVYREV, Triasovye ammonoidei yuga SSSR, p. 131, figs. 33, 34, pl. IX, fig. 1.
v 1987 *Beyrichites* cf. *reuttensis* (BEYRICH, 1867) — VÖRÖS, Preliminary results from Aszófő, p. 56, pl. III, fig. 7.
v 1991 *Beyrichites* cf. *reuttensis* (BEYRICH, 1867) — TATZREITER & VÖRÖS, Vergleich der pelsonischen..., p. 253.

Material: A single specimen of medium state of preservation, from Aszófő.
Dimensions:

D	WH	WW	U
22.0	11.5	?	3.5

Description: Small specimen with partially preserved body chamber. Compressed shell with rather involute coiling. The whorl-section is high oval. The umbilical shoulder is not pronounced. The flank is gently convex and passes gradually to the highly arched, narrow venter. The ornamentation is weak; it consists of widely spaced, slightly sinuous ribs fading out near the venter. In the outer (ventral) part of the flank, very weak, irregular, flared secondary ribs are inserted between the primaries.

Suture lines were not seen.

Remarks: *B. reuttensis* differs from other *Beyrichites* by its widely spaced primary ribs and by the appearance of inserted, flared secondaries.

REIS (1901, l. c.) figured only a cross-section which does not permit a definite attribution. His subsequent record (REIS 1907, l. c.) is much more convincing; particularly the specimen figured on pl. III, fig. 1, 1a, shows the characteristic ribbing of *B. reuttensis*. The figure given by MARTELLI (1904, l. c.) is not at all informative. The figures published by VENZO & PELOSIO (1968, l. c.) are regarded as perfect and reliable illustration of the species.

Distribution: *B. reuttensis* was described and repeatedly cited from the Anisian of the Southern Alps. Later on it was found in the Northern Calcareous Alps (Wetterstein Limestone), the Dinarides and the Caucasus. At the Balaton Highland, the single specimen was collected in the Aszófő section, in the Binodosus Subzone.

Beyrichites ? *sp.*

Plate A-VII, 11.

Material: Two incomplete specimens of medium state of preservation, from Aszófő.

Dimensions: The specimens were not suitable for measuring, but the larger one might exceed 9 cm in diameter.

Description: The larger specimen is an incomplete mould of a body chamber with only one side preserved. It was a moderately compressed, rather involute conch. The whorl-section appears to be high-oval. The flank is slightly convex and passes gradually to the arched venter. The flank is ornamented with very weak, gently sinuous radial ribs becoming stronger ventrally and vanishing on the venter. Strigation (three to four, weak, spiral cords) is also visible on the flank.

Suture lines were not preserved.

Remarks: The strigate ornamentation appears to be extraordinary among *Beyrichites*, nevertheless, the general shape and ribbing of this form support this generic assignment.

Distribution: The specimens were collected in the Aszófő section from the Binodosus Subzone.

Genus Schreyerites TATZREITER & BALINI, 1993

In their very sound analytical work, TATZREITER & BALINI (1993) set extremely narrow limits for this genus (especially for the suture line with exactly five saddles as a strict requirement). In this interpretation, *Schreyerites* includes only *S. abichi* (MOJSISOVICS, 1882) (the type species) and *S. splendens* (ARTHABER, 1896), and this opinion is essentially still held on (M. BALINI 2001, pers. comm.). However, for practical reasons (*e.g.* to avoid establishing further new genera), it seems to be reasonable to extend the scope of this genus to other species of this kind of external morphology, having subammonitic sutures with four to six saddles on the flanks. In this case, *Schreyerites* would include also *Meekoceras ragazzonii* MOJSISOVICS, *Ceratites loretzi* MOJSISOVICS and *A. (Ceratites) binodosus* HAUER, among others (MIETTO & MANFRIN 2002, pers. comm.). This wider interpretation of the genus *Schreyerites* is preferred and used in the present work.

Schreyerites loretzi (MOJSISOVICS, 1882)

Plate A-VIII, 1, 2; Figures A-24, A-25.

* 1882 *Ceratites Loretzi* E. v. MOJSISOVICS — MOJSISOVICS, Ceph. mediterr. Triasprovinz, p. 21, pl. XI, figs. 6a–b, 7.
v ? 1896 *Ceratites binodosus* HAUER. — ARTHABER, Cephalopod. Reiflinger Kalke (II), p. 197, pl. XI, fig. 1.
? 1904 *Ceratites Loretzi* MOJSISOVICS 1878. — MARTELLI, Boljevici presso Vir nel Montenegro, p. 87, pl. V, fig. 8.
v 1987 *Beyrichites* ? *loretzi* (MOJSISOVICS, 1878) — VÖRÖS, Preliminary results from Aszófő, p. 55, pl. I, figs. 5, 6a–b.
v 1987 *Beyrichites abichi* (MOJSISOVICS, 1882) — VÖRÖS, Preliminary results from Aszófő, p. 55.
v 1991 *"Gangadharites" loretzi* MOJSISOVICS, 1878) — TATZREITER & VÖRÖS, Vergleich der pelsonischen..., p. 253, pl. 2, fig. 3.
v 1991 *"Gangadharites" abichi* (MOJSISOVICS, 1882) — TATZREITER & VÖRÖS, Vergleich der pelsonischen..., p. 253.

Material: 22 specimens of variable state of preservation, mostly with silicified shells; all from Aszófő.

Dimensions:

D	WH	WW	U
64.8	33.0	>13.0	8.0
52.3	28.0	13.0	6.0
50.0	25.0	>9.0	8.0
36.3	18.5	10.0	5.5
35.2	18.5	8.7	5.0

Description: Medium to large-sized *Schreyerites* with compressed, rather involute conch. The whorl-section is high oval to subtriangular. The umbilical wall is moderately steep; the umbilical margin is subrounded. The flanks are gently convex and form a blunt ventrolateral margin with the highly arched to feebly fastigate venter. The ornamentation consists of rather regularly spaced slightly sinuous ribs and nodes. The umbilical part is almost smooth, without nodes and

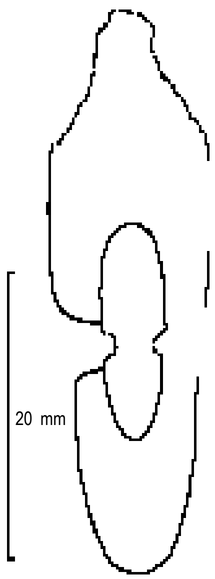

Figure A-24. Cross section of *Schreyerites loretzi* (MOJSISOVICS, 1882), (2003.78.1.), Aszófő I, Bed 10, Balatonicus Zone, Cadoricus Subzone

with very weak ribbing. Secondary ribs are inserted at around the mid-flank; bifurcation was not observed. The ribs become stronger ventrally and bear distinct clavi at their ventrolateral end. The clavi are strongly projected adorally and may be very pronounced. At around the mid-flank, the primary ribs bear faint but very prominent, frequently pointed nodes.

The suture lines are subammonitic and only partially seen. The lateral lobe is rather deep and strongly indented. The saddles are more or less incised.

Remarks: On the basis of its external morphology, this species stands close to *S. abichi* (MOJSISOVICS); TATZREITER & BALINI (1993, p. 9) differentiated them only by the details of the suture lines. Additionally, the stronger ornamentation of the immature specimens of *S. loretzi* (*e.g.* Plate A-VIII, 2, herein) may give basis for separation from *S. abichi*.

The *"Ceratites binodosus"* specimen figured by ARTHABER (1896, l. c.) stands closer to *S. loretzi* than to *S.* ? *binodosus* (HAUER) because of its projected ventrolateral clavi. MARTELLI's (1904, l. c.) figure is rather poor; the presence of lateral nodes is the only informative character. One specimen from Aszófő was previously determined as *B. abichi* (VÖRÖS 1987, l. c.) but in the lack of detailed information on its suture, it seems to be a smaller mistake to include it to *S. loretzi*.

This species was cited by some authors with 1878 as the year of publication, with reference to MOJSISOVICS (1879). However, in this magnificent geological description ("Dolomit-Riffe von Südtirol") the new species names are only listed, without any other information, therefore they must be taken as *nomina nuda*.

Distribution: *S. loretzi* was described from the Anisian of the Southern Alps; it probably occurs in the Northern Calcareous Alps and the Dinarides. At the Balaton Highland it was collected in the Aszófő section, where it ranges from the Cadoricus Subzone to the Zoldianus Subzone.

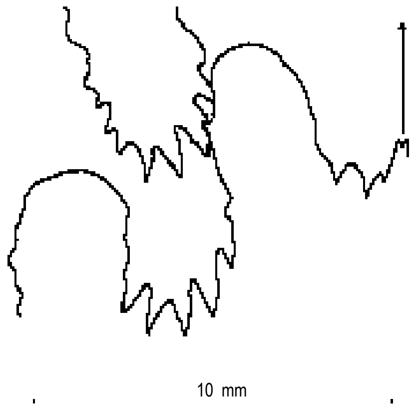

Figure A-25. Suture lines of *Schreyerites loretzi* (MOJSISOVICS, 1882), (2003.94.1.), Aszófő I, Bed 22, Balatonicus Zone, Cadoricus Subzone

Schreyerites ragazzonii **(MOJSISOVICS, 1882)**

Plate A-VII, 13, 14, 15, 16; Figures A-26, A-27, A-28.

v * 1882 *Meekoceras Ragazzonii* E. v. MOJSISOVICS — MOJSISOVICS, Ceph. mediterr. Triasprovinz, p. 217, pl. XXXIX, figs. 3a–b, pl. LXI, fig. 5.

1968 *Beyrichites (Gangadharites ?) ragazzonii* (MOJS.) — VENZO & PELOSIO, Anisico superiore di Lenna, p. 97, pl. VIII, figs. 1, 2a–c, 3a–d, 5a–d, 8a–d, (? 4a–b).

? 1973 *Beyrichites ragazzonii* (MOJSISOVICS) — PELOSIO, Trias medio di Asklepieion, p. 154, pl. XVI, figs. 1a–b, pl. XXI, fig. 2.

v 1987 *Beyrichites ragazzonii* (MOJSISOVICS, 1882) — VÖRÖS, Preliminary results from Aszófő, p. 56, pl. III, figs. 5a–b.

v 1991 *"Gangadharites" ragazzonii* (MOJSISOVICS, 1882) — TATZREITER & VÖRÖS, Vergleich der pelsonischen..., p. 253.

Material: 62 specimens of variable state of preservation; 61 from Aszófő, 1 from Mencshely (Cser-tető III).

Dimensions:

D	WH	WW	U
74.0	40.0	?	11.0
56.0	29.0	15.0	11.0
51.5	27.6	>14.5	7.0
37.5	17.5	10.6	8.5

Description: Small to medium-sized *Schreyerites*. The whorl-section is high oval to subpentagonal; the maximum width reached at mid-whorl. The umbilical wall is steep; the umbilical margin is rather well marked. The flanks are flat and divergent in the umbilical part, then become moderately convex; they form a blunt ventrolateral margin with the highly arched to gently fastigate venter. The ornamentation consists of rather irregularly developed, sinuous ribs and nodes. The umbilical part bears very weak ribbing. Bifurcation was not observed; the insertion of secondary ribs is rather irregular. The ribs become stronger ventrally and bear flat but distinct, adorally projected clavi at their ventrolateral end. At around the mid-flank, the ribs bear faint but prominent, frequently pointed nodes. The spacing and development of these nodes fluctuates together with the development of the ribs.

The suture line is subammonitic, with four saddles on the flank. The lateral lobe is very deep and strongly indented. The fourth saddle (near the umbilical margin) is deeply slit.

Remarks: In its external morphology, *S. ragazzonii* has close similarity to *S. abichi* and *S. loretzi,* from which it differs in the high subpentagonal whorl-section and in the strikingly irregular development of ornamentation with strongly sinuous ribs and weaker ventrolateral clavi. The suture of *S. ragazzonii* has strong resemblance to that of *S. abichi*, except the number of saddles (four, instead of five).

The figures published by VENZO & PELOSIO (1968, l. c.) are regarded as perfect and reliable illustration of the species, with the exception of figs. 4a–b, which portrays a large specimen with very strong, pointed lateral nodes. This specimen, as VENZO & PELOSIO (l. c.) also stated, may stand closer to *S. abichi* (MOJSISOVICS, 1882). The specimen figured by PELOSIO (1973, l. c.) does not show the characteristic lateral nodes, therefore its attribution to *S. ragazzonii* is taken as doubtful.

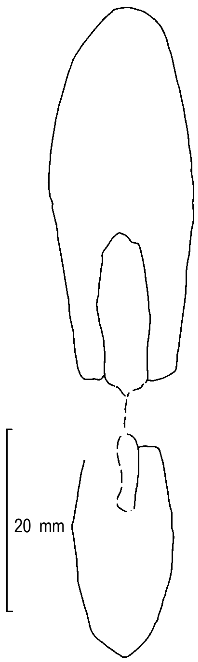

Figure A-26. Cross section of *Schreyerites ragazzonii* (MOJSISOVICS, 1882), (2003.77.1.), Aszófő I, Bed 80, Balatonicus Zone, Zoldianus Subzone

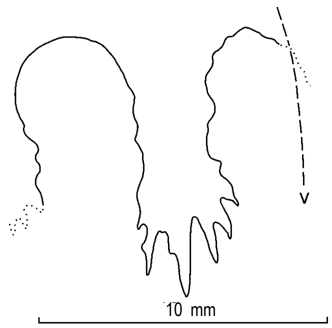

Figure A-27. Suture line of *Schreyerites ragazzonii* (MOJSISOVICS, 1882), (2003.91.1.), Aszófő I, Bed 79, Balatonicus Zone, Zoldianus Subzone
v = ventral margin

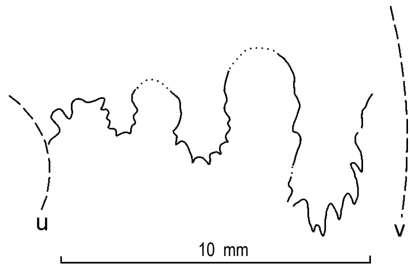

Figure A-28. Suture line of *Schreyerites ragazzonii* (MOJSISOVICS, 1882), (2003.92.1.), Aszófő I, Bed 77, Balatonicus Zone, Zoldianus Subzone.
u = umbilical margin, v = ventral margin

Distribution: *S. ragazzonii* was described from the Anisian of the Southern Alps; it probably occurs in Epidhavros. At the Balaton Highland it was collected in the Aszófő and the Mencshely (Cser-tető III) sections, where it ranges from the Zoldianus Subzone to the Binodosus Subzone.

Schreyerites **sp., aff.** ***splendens*** **ARTHABER, 1896**

Plate A-VIII, 3a–b.

v 1987 *Beyrichites* ? *splendens* ARTHABER, 1896 — VÖRÖS, Preliminary results from Aszófő, p. 56.

Material: A single, incomplete specimen with silicified shell, from Aszófő.

Dimensions:

D	WH	WW	U
97.5	51.0	29.5	10.5

Description: Large-sized, compressed, rather involute conch with contracting body chamber. The phragmocone is largely crushed; the cross-section of the body chamber is high trapezoidal to subhexagonal. The umbilical wall is steep, slightly overhanging. The umbilical shoulder is rather well marked. The flanks are flat and divergent in the umbilical part, then become moderately convex; they form a distinct ventrolateral shoulder with the low arched to tabulate venter. The venter is arched to gently fastigate in the penultimate whorl. The flanks are ornamented with faint growth lines; very weak, slightly sinuous, flared ribs and irregular lateral nodes appear on the body chamber. The umbilical and ventrolateral margins bear no nodes. On the venter, longitudinal striae appear on the surface of the inner mould of the body chamber.

Sutures are not known.

*Remarks***:** This specimen has some similarity to that figured as *"Beyrichites splendens"* by ARTHABER (1896b, p. 229, pl. XV, figs. 1a–c), though the tabulate venter is not as marked on Arthaber's original specimen as in the figure, and the clavate ventrolateral margin makes another significant difference.

Distribution: The single specimen was collected in the Aszófő section, from the Cadoricus Subzone.

Schreyerites ? binodosus **(Hauer, 1851)**

Plate A-VIII, 4, 5, 6a–b, 7; Figure A-29.

* 1851 *A. (Ceratites) binodosus* n. sp. — Hauer, Venetianer Alpen gesammelten fossilien, p. 114 (partim), pl. XIX, figs. 1a–c. non figs. 2, 3, 4).
? 1867 *Ammonites binodosus* Hau. — Beyrich, Über einige Cephalopoden, p. 107, pl. I, figs. 1a–c, 2a–b.
v 1882 *Ceratites binodosus* Fr. v. Hauer. — Mojsisovics, Ceph. mediterr. Triasprovinz, p. 19, pl. XI, figs. 1a–c, 2a–b, 3 (?), 4, 5a–b.
v ?1896 *Ceratites binodosus* Hauer — Arthaber, Cephalopod. Reiflinger Kalke (I), p. 48, pl. IV, figs. 3a–c.
v non 1896 *Ceratites binodosus* Hauer. — Arthaber, Cephalopod. Reiflinger Kalke (II), p. 197, pl. XI, fig. 1.
v 1915 *Ceratites binodosus* Hau. Var. — Arthaber, Die Trias von Bithynien, p. 121, pl. XII, figs. 1a–d.
v non 1915 *Ceratites binodosus* Hau. — Arthaber, Die Trias von Bithynien, p. 122, pl. XII, figs. 2a–c.
v non 1916 *Ceratites cf. binodosus* Hauer — Lóczy, Die geologischen Formationen der Balatongegend, p. 112.
v ?1934 *Paraceratites binodosus* (Hauer) — Spath, Catalogue British Museum, Trias, p. 435 (partim).
v 1987 *Paraceratites* cf. *binodosus* (Hauer, 1850) — Vörös, Preliminary results from Aszófő, p. 55, pl. III, fig. 6.
? 1988 *Paraceratites binodosus* (Hauer, 1850) — Fantini Sestini, Anisian Ammonites from Gebze, p. 61, pl. 13, fig. 7.
v 1991 *"Ceratites"* cf. *binodosus* (Hauer, 1850) — Tatzreiter & Vörös, Vergleich der pelsonischen..., p. 253.
1995 *Schreyerites binodosus* (Hauer, 1851) — Mietto & Manfrin, Middle Triassic ammonoid standard scale, p. 547, pl. I, figs. 6, 7, (? figs. 9, 12).
v 2002 *Schreyerites* ? cf. *binodosus* (Hauer, 1851) — Vörös & Pálfy, The Pelsonian at Köveskál, p. 55. pl. I, fig. 7.

Material: 14 specimens of mostly poor state of preservation; 1 from Aszófő, 1 from Mencshely (Cser-tető III), 7 from Felsőörs and 5 from Köveskál (Horog-hegy).

Dimensions:

D	WH	WW	U
52.7	24.1	14.0	8.0
33.0	16.5	?	5.5
30.0	15.0	8.2	5.0

Description: Small to medium-sized *Schreyerites* with moderately involute, compressed conch. The whorl-section is high oval to subtrapezoidal. The umbilical wall is steep to overhanging; the umbilical margin is rather well marked. The flanks are gently convex and meet with the arched venter at a blunt ventrolateral margin. The ornamentation consists of weak, radial, slightly sinuous ribs and nodes. The ribs become stronger ventrally; their number increases by irregular insertion of secondary ribs; bifurcation is rare. The umbilical margin bears no nodes. The lateral nodes are rather weak and lie around the mid-whorl. The ventrolateral nodes have the form of pointed but not projected clavi.

Sutures are not known.

Remarks: Hauer's (l. c.) extremely widely interpreted type series of "*C. binodosus*" was split into three species by Mojsisovics (1869, 1882). The specimen shown in pl. XIX, figs. 1a–c of Hauer (1851) was selected as the type of "*Ammonites Cadoricus*" (Mojsisovics, 1869, p. 583); the body chamber depicted in Hauer's pl. XIX, figs. 3a–b became the type of "*Ceratites zoldianus*" (Mojsisovics, 1882), whereas the specimen illustrated in pl. XIX, figs. 2a–c of Hauer (1851) remained the type of the species *binodosus*. Mojsisovics' (l. c.) figured specimens were examined in the collection of the Geologische Bundesanstalt (Vienna): the specimens on pl. XI, figs 1 and 2 were considered as particularly typical for *S. binodosus*; the specimens from the Balaton Highland stand close to these.

Arthaber's (1896a, b) specimens were also seen in the collection of the Geologische Bundesanstalt (Vienna). One of them (l. c., pl. IV, figs. 3a–c), though rather coarsely ornamented, seems to fit into the variation of *S. binodosus*. The other (l. c., pl. XI, fig. 1) shows a quite different ornamentation.

The original specimens of Arthaber (1915, Bithynien) were examined when they were on loan from Stuttgart at F. Tatzreiter in Vienna. The specimen figured by Arthaber (l. c.) on pl. XII, figs. 1a–d, fits well to the present author's concept of *S. binodosus* (*i.e.* matches with Hauer's original fig. 1). The other specimen of Arthaber (l. c. pl. XII, figs. 2a–c), which he described explicitly as typical *binodosus*, is regarded here as belonging to some quite different taxon.

Lóczy's record (1916, l. c.) from the Balaton Highland (two specimens from Köveskál) was revised in the collections of the GIH (Budapest); one of the specimens (inventory number: T.99.) is rather a *P. trinodosus*, the other (T.122.) belongs to the genus *Lardaroceras*.

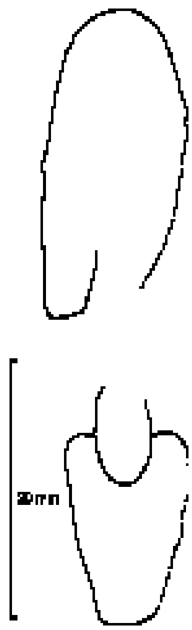

Figure A-29. Cross section of *Schreyerites ? binodosus* (Hauer, 1851), (2003.83.1.), Felsőörs, Bed 78, Balatonicus Zone, Binodosus Subzone

Several specimens, registered by SPATH (1934) as *"Paraceratites binodosus"*, were seen in the collection of the Natural History Museum (London). These came from Diliskelessi (Turkey) and may belong to *Schreyerites* but their ribbing is stronger and more sinuous, with ventrolateral, projected clavi, therefore they may be closer to *S. abichi* or *S. loretzi*.

The ornamentation of the specimen figured by FANTINI SESTINI (1988, l. c.) shows strong similarity to *S. binodosus* but its suture is ceratitic, not of *Schreyerites* type. This record is taken as doubtful also because the specimens were found in the deeper level of the Balatonicus Subzone, together with *Balatonites ottonis*-like forms. This contradicts to the stratigraphical record of the Alpine areas where *"binodosus"* appears regularly in the highest levels of, or higher than the *"Balatonites*-range*"* (though a greater overlap or shift of the ranges can be considered as well).

The species *binodosus* was definitely not included to *Schreyerites* by TATZREITER & BALINI (1993) on the basis of different number of saddles on their subammonitic suture lines. On the other hand, MIETTO & MANFRIN (1995, and pers. comm. 2002) suggested a somewhat wider interpretation of *Schreyerites* what is accepted here.

Distribution: S. binodosus was described from the Anisian of the Southern Alps. Later on, it was found also in the Northern Calcareous Alps and in the Balaton Highland. The Bithynian occurrence is doubtful. At the Balaton Highland it was collected in the Aszófő, the Felsőörs, the Köveskál (Horog-hegy) and the Mencshely (Cser-tető III) sections, where its range is restricted to the Binodosus Subzone.

Subfamily Paraceratitinae SILBERLING, 1962

Genus **Semiornites** ARTHABER, 1912

***Semiornites* sp.**

Plate A-VIII, 8a–b.

v 1987 *Semiornites* cf. *lennanus* (MOJSISOVICS, 1882) — VÖRÖS, Preliminary results from Aszófő, p. 55.
v 1998 *Semiornites aviticus* — VÖRÖS, A Balaton-felvidék triász ammonoideái, p. 21.

Material: Nine incomplete specimens (mostly fragments of body chambers); 6 from Aszófő, 3 from Felsőörs.

Dimensions:

D	WH	WW	U
?	31.0	19.0	?

Description: Incomplete moulds of body chambers, representing medium-sized ammonoids. The whorl-section is high subtrapezoidal, with steep umbilical walls, subrounded umbilical margins, gently convex flanks, marked ventrolateral margins and subtabulate to slightly arched venter. The ornamentation of the body chamber is very weak. Faint, slightly sinuous and prorsiradiate riblets are seen on the flanks. The ventrolateral ends of the riblets develop into adorally projected, weak clavi.

Sutures are not known.

Remarks: Some of these fragmentarily preserved specimens were previously tentatively determined as *S. lennanus* and *S. aviticus* by the present author, however, the morphological information is now taken as insufficient for specific identification.

Distribution: At the Balaton Highland these forms were collected in the Aszófő and the Felsőörs sections, where they range from the Zoldianus Subzone to the Binodosus Subzone.

Superfamily Pinacocerataceae MOJSISOVICS, 1879
Family Ptychitidae MOJSISOVICS, 1882

Genus **Discoptychites** DIENER, 1916

***Discoptychites domatus* (HAUER, 1851)**

Plate A-VIII, 9a–b, 10; Figure A-30.

* 1851 *A. Domatus* n. sp. — HAUER, Venetianer Alpen gesammelten fossilien, p. 115, pl. XVIII, figs. 12a–c.
v 1872 *Amm.* cfr. *domatus* HAU. — BÖCKH, A Bakony déli részének földtani viszonyai, p.75.
1882 *Ptychites domatus* (Fr. v. HAUER) — MOJSISOVICS, Ceph. mediterr. Triasprovinz, p. 250, pl. LXII, figs. 4a–b, 5a–c.
1896 *Ptychites domatus* HAUER. — ARTHABER, Cephalopod. Reiflinger Kalke (II), p. 232, pl. XIV, figs. 10a–b.
v 1916 *Ptychites domatus* HAUER. — LÓCZY, Die geologischen Formationen der Balatongegend, p.115.
1963 *Discoptychites domatus* (HAUER) 1851. — ASSERETO, Anisico della Val Camonica, p. 77, pl. XI, figs. 2a–c.
v 1987 *Discoptychites* cf. *domatus* (HAUER, 1850) — VÖRÖS, Preliminary results from Aszófő, p. 56, pl. II, fig. 6.
v 1991 *Discoptychites* cf. *domatus* (HAUER, 1850) — TATZREITER & VÖRÖS, Vergleich der pelsonischen..., p. 253.

Material: 15 specimens of variable state of preservation, partly with silicified shells; 7 from Aszófő, 7 from Mencshely (Cser-tető III) and 1 from Veszprém ("Szabadság-puszta").

Dimensions:

D	WH	WW	U
48.0	23.5	31.0	12.4
46.8	19.5	>25.5	10.8
41.2	12.0	29.0	?
35.5	16.0	23.0	12.3

Description: Small to medium-sized, partly immature *Discoptychites* conchs. The coiling is moderately evolute and depressed, cadicone with deeply excavated umbilicus. The umbilical wall is becoming steeper during growth. The umbilical margin is subrounded but well defined. The flank and venter together form a continuous arch; the maximum convexity lies at the mid-venter. The surface is ornamented with very fine, irregularly spaced growth lines; weak constrictions may occur.

Sutures are not known.

Remarks: There are some smooth ptychitids (*e.g. "Ptychites pauli"* MOJSISOVICS, 1882, *"P. suttneri"* MOJSISOVICS, 1882, *"P. evolvens"* MOJSISOVICS, 1882) whose inner whorls or juvenile specimens strongly resemble *D. domatus*, but even if one considers them conspecific, *D. domatus* has priority over the other names.

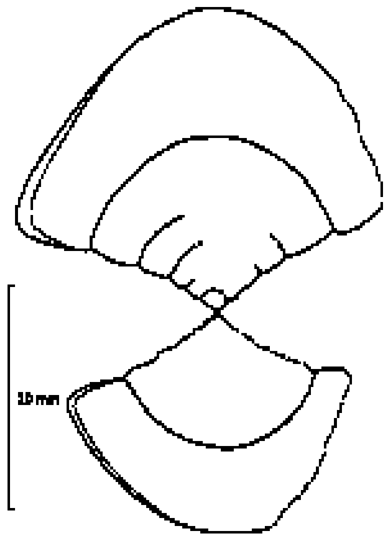

Figure A-30. Cross section of *Discoptychites domatus* (HAUER, 1851), (2003.79.1.), Mencshely (Cser-tető), loose, Balatonicus Zone, Balatonicus Subzone (?)

LÓCZY's record (1916, l. c.) from the Balaton Highland was revised in the collections of the GIH (Budapest); the specimen from Mencshely (inventory number: T.336.) is a perfect representative of *D. domatus*.

Distribution: This species was desribed from the Anisian of the Southern Alps, then it was found also in the Northern Calcareous Alps and in the Balaton Highland. At the Balaton Highland it was collected from the Aszófő and the Mencshely (Cser-tető III) sections where it ranges through the Balatonicus and Cadoricus Subzones.

Superfamily Danubitaceae SPATH, 1951
Family Danubitidae SPATH, 1951

Genus **Judicarites** MOJSISOVICS, 1896

***Judicarites* cf. *euryomphalus* (BENECKE, 1865)**

Plate A-VIII, 11a–b.

* 1865 *Ceratites euryomphalus.* BENECKE — BENECKE, Trias und Jura in den Südalpen, p. 154, pl. II, figs. 1a–b.

1882 *Balatonites euryomphalus* (BENECKE) E. v. M. — MOJSISOVICS, Ceph. mediterr. Triasprovinz, p. 84, pl. VI, figs. 6a–b, pl. XXXVIII, fig. 6a–b.

1969 *Judicarites euryomphalus* (BENECKE) — GAETANI, Anisico Giudicarie, p. 546, pl. 37, figs. 7a–b, 8a-b.

? 1986 *Judicarites* aff. *euryomphalus* (BENECKE, 1866 emed MOJSISOVICS, 1882) — RAKÚS, Ammonites of Reifling Limestones, p. 82, pl. 1, fig. 9.

v 2002 *Judicarites* cf. *euryomphalus* (BENECKE, 1866) — VÖRÖS & PÁLFY, The Pelsonian at Köveskál, p. 55. pl. I, figs. 5a–b.

Material: A single, poorly preserved body chamber fragment, from Köveskál (Horog-hegy).

Dimensions: The specimen was not suitable for measuring.

Description: Small-sized *Judicarites*. The features of coiling and whorl-section are only partly seen. The flanks are almost flat; the ventrolateral shoulder is marked; the venter is subtabulate, tricarinate. The flanks are ornamented with strong, prorsiradiate, slightly sinuous ribs becoming more prominent and projected at the ventrolateral shoulder, where this row of elevations form a crenulated carina. There is another, low, but distinct carina at the middle of the venter, bordered by two, shallow, longitudinal furrows.

Sutures are not known.

Remarks: MOJSISOVICS (1882, l. c.) described and profusely illustrated *J. arietiformis* and *J. prezzanus*, besides *J. euryomphalus* (BENECKE), all from Prezzo. These three forms apparently stand very close in their external morphology and may represent a single, variable species. If this is true (and would hopefully be proved by studies on the rich material from the Prezzo Limestones), the name *J. euryomphalus* as senior synonym should be applied. This species was cited by some authors with 1866 as the year of publication, however, it is definitely stated in the contents of the monograph series ("Benecke's Beiträge") that this part ("Über Trias und Jura in den Südalpen") was published in 1865.

RAKÚS (1986, l. c.) published a poor figure but the informative description seems to validate his species assignment.

Distribution: *J. euryomphalus* was described from the Anisian of the Southern Alps; later on, it was found also in the West Carpathians and the Balaton Highland. Here, the single specimen was collected from the Binodosus Subzone in the Köveskál (Horog-hegy) section.

Family Longobarditidae SPATH, 1951
Subfamily Noetlingitinae PARNES, 1975

Genus **Noetlingites** HYATT, 1900
***Noetlingites* sp.**
Plate A-VIII, 12a–b.

? 1980 Hungarites sp. — GU *et al.*, Late Anisian from Doilungdeqen, p. 354, pl. II, figs. 6, 7.

Material: A single, poorly preserved, incomplete mould of a body chamber from Aszófő.

Dimensions: The specimen was not suitable for measuring but its diameter might exceed 8 cm.

Description: Medium-sized *Noetlingites*. Involute, compressed oxycone conch. The flanks are slightly convex; the ventrolateral shoulder is well-marked; the venter is fastigate, sharpened. Ornamentation is barely visible, except a low spiral cord on the flank, at about one cm distance from the ventrolateral shoulder.

Sutures are not known.

Remarks: The genus *Noetlingites* can easily be identified by its very characteristically fastigate ventral part. The presence of longitudinal (spiral) ornamentation (as stressed also by TATZREITER 2001, p. 160), and the definitely deeper stratigraphical occurrence separate *Noetlingites* from some *Hungarites* with similar ventral part.

The specimen figured by GU *et al.* 1980, l. c.) shows remarkable similarity to that from Aszófő and belongs very probably to *Noetlingites* (as raised also but doubted in the absence of suture lines by TATZREITER 2001, p. 148).

Distribution: *Noetlingites* was considered as a typical genus of the Germanic Lower Muschelkalk, but recently it was found in the Northern Calcareous Alps (TATZREITER 2001), and, probably in the Southern Alps (MIETTO & MANFRIN 1995, p. 546) and in Tibet. At the Balaton Highland, the single specimen was collected from the Balatonicus Subzone in the Aszófő section.

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Plate A-I.
(All figures in natural size.)

1. *Proavites hueffeli* ARTHABER, 1896 — 2003.1.1., Aszófő I, Bed 3, Balatonicus Zone, Balatonicus Subzone.
2. *Proavites hueffeli* ARTHABER, 1896 — 2003.2.1., Aszófő I, Bed 14, Balatonicus Zone, Cadoricus Subzone.
3. *Proavites hueffeli* ARTHABER, 1896 — 2003.3.1., ventral (a) and lateral (b) views. Aszófő I, Bed 21, Balatonicus Zone, Cadoricus Subzone.
4. *Proavites hueffeli* ARTHABER, 1896 — 2003.4.1., lateral (a) and ventral (b) views. Aszófő I, Bed 3, Balatonicus Zone, Balatonicus Subzone.
5. *Norites gondola* (MOJSISOVICS, 1869) — 2003.7.1., lateral (a) and ventral (b) views. Aszófő I, Bed 3, Balatonicus Zone, Balatonicus Subzone.
6. *Norites gondola* (MOJSISOVICS, 1869) — 2003.5.1., Aszófő I, Bed 15, Balatonicus Zone, Cadoricus Subzone.
7. *Norites gondola* (MOJSISOVICS, 1869) — 2003.6.1., Aszófő I, Bed 42, Balatonicus Zone, Cadoricus Subzone.
8. *Norites falcatus* ARTHABER, 1896 — 2003.8.1., Aszófő I, Bed 13, Balatonicus Zone, Cadoricus Subzone.
9. *Norites falcatus* ARTHABER, 1896 — 2003.10.1., Aszófő I, Bed 17, Balatonicus Zone, Cadoricus Subzone.
10. *Norites falcatus* ARTHABER, 1896 — 2003.9.1., Aszófő II, Bed 7, Balatonicus Zone, Balatonicus Subzone.
11. *Acrochordiceras carolinae* MOJSISOVICS, 1882 — 2003.11.1., Aszófő II, Bed 5, Balatonicus Zone, Balatonicus Subzone.
12. *Acrochordiceras carolinae* MOJSISOVICS, 1882 — 2003.13.1., Aszófő I, Bed 14, Balatonicus Zone, Cadoricus Subzone.
13. *Acrochordiceras carolinae* MOJSISOVICS, 1882 — 2003.12.1., Aszófő II, Bed 5, Balatonicus Zone, Balatonicus Subzone.
14. *Acrochordiceras carolinae* MOJSISOVICS, 1882 — 2003.14.1., ventral (a) and lateral (b) views. Aszófő II, loose (around Bed 3), Balatonicus Zone, Balatonicus Subzone.
15. *Balatonites* cf. *ottonis* (BUCH, 1849) — 2003.15.1., Aszófő II, Bed 33, Ismidicus Zone, Ottonis Subzone.
16. *Balatonites balatonicus* (MOJSISOVICS, 1873) — 2003.16.1., Mencshely (Cser-tető III), Bed 15, Balatonicus Zone, Cadoricus Subzone
17. *Balatonites balatonicus* (MOJSISOVICS, 1873) — 2003.18.1., Aszófő I, Bed 12, Balatonicus Zone, Cadoricus Subzone.
18. *Balatonites balatonicus* (MOJSISOVICS, 1873) — 2003.17.1., Aszófő I, Bed 15, Balatonicus Zone, Cadoricus Subzone.

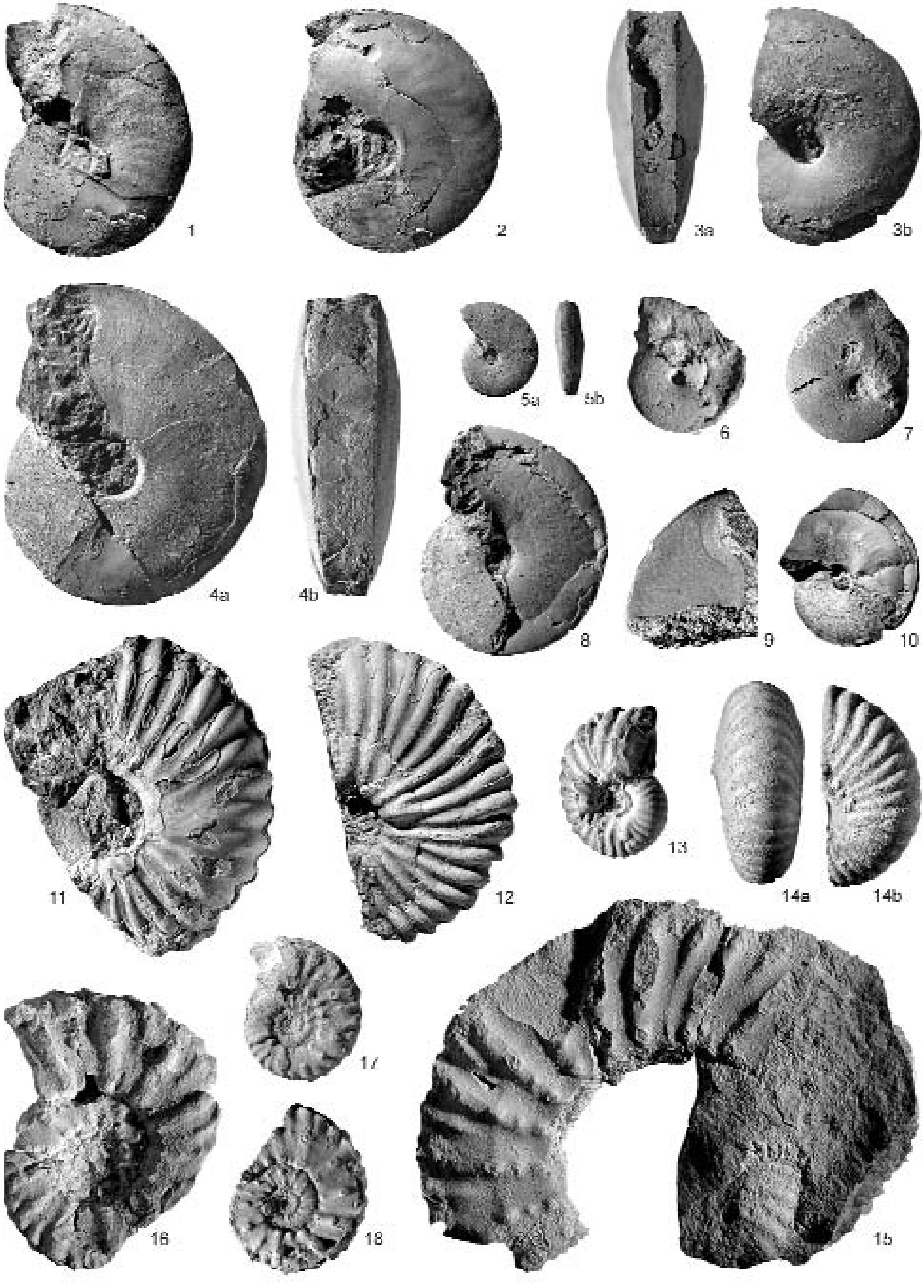
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Plate A-II.

(All figures in natural size unless otherwise indicated.)

1. *Acrochordiceras* cf. *damesii* (NOETLING, 1880) — 2003.72.1., ventral (a) and lateral (b) views (2/3×). Aszófő II, Bed 40 or 41, Ismidicus Zone, Ottonis Subzone.
2. *Balatonites balatonicus* (MOJSISOVICS, 1873) — 2003.33.1., lateral (a) and ventral (b) views. Aszófő I, Bed 3, Balatonicus Zone, Balatonicus Subzone.
3. *Balatonites balatonicus* (MOJSISOVICS, 1873) — 2003.29.1., lateral (a) and ventral (b) views. Aszófő I, Bed 3, Balatonicus Zone, Balatonicus Subzone.

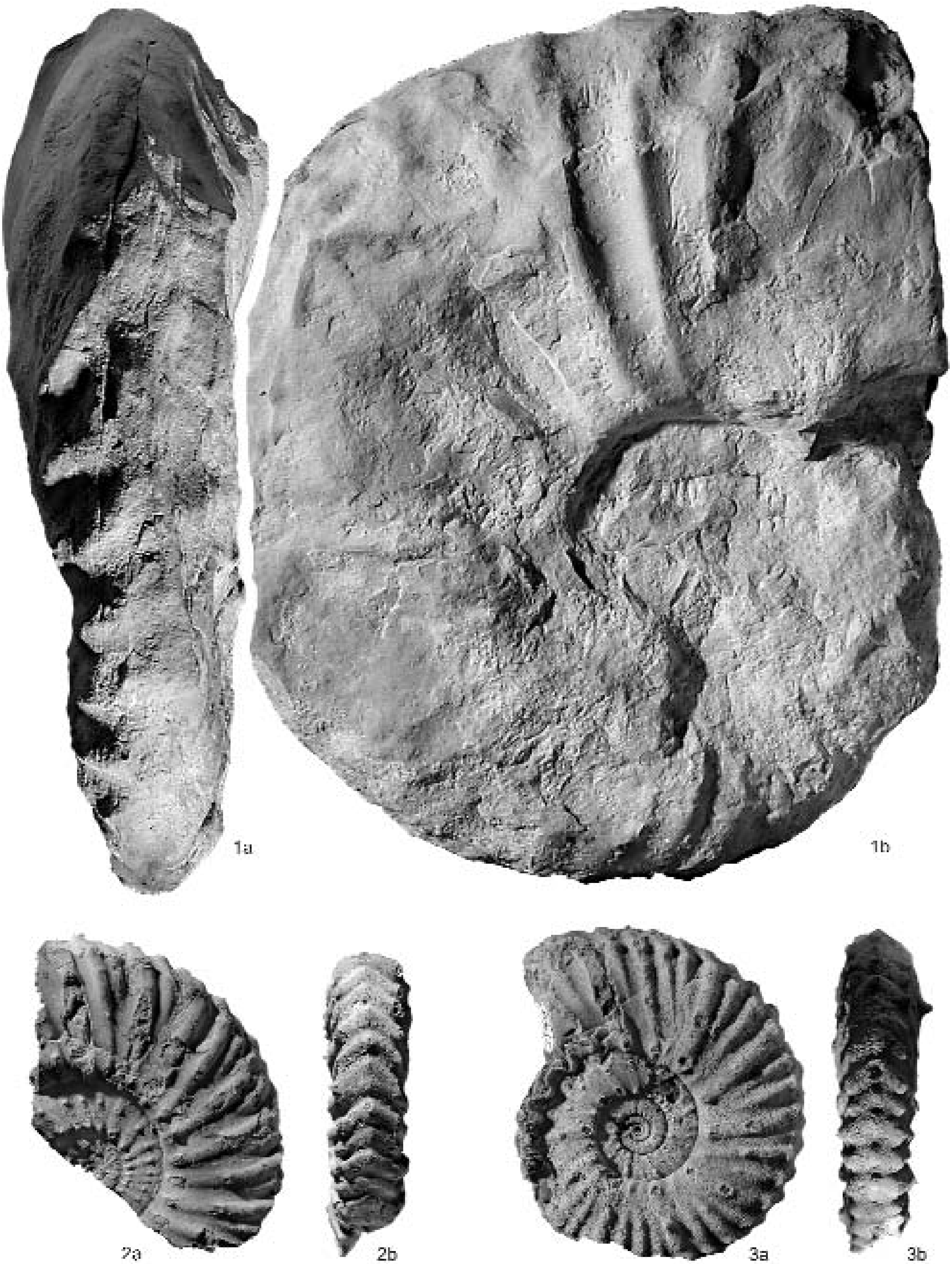
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Plate A-III.

(All figures in natural size unless otherwise indicated.)

1. *Acrochordiceras* cf. *damesii* (NOETLING, 1880) — 2003.72.1. (2/3×), Aszófő II, Bed 40 or 41, Ismidicus Zone, Ottonis Subzone.
2. *Balatonites balatonicus* (MOJSISOVICS, 1873) — 2003.34.1., lateral (a) and ventral (b) views. Aszófő I, Bed 4, Balatonicus Zone, Balatonicus Subzone.
3. *Balatonites balatonicus* (MOJSISOVICS, 1873) — 2003.32.1., lateral (a) and ventral (b) views. Mencshely (Cser-tető III), Bed 19, Balatonicus Zone, Cadoricus Subzone.
4. *Balatonites balatonicus* (MOJSISOVICS, 1873) — 2003.28.1., Aszófő I, Bed 19, Balatonicus Zone, Cadoricus Subzone.
5. *Balatonites balatonicus* (MOJSISOVICS, 1873) — 2003.27.1., Aszófő I, Bed 15, Balatonicus Zone, Cadoricus Subzone.

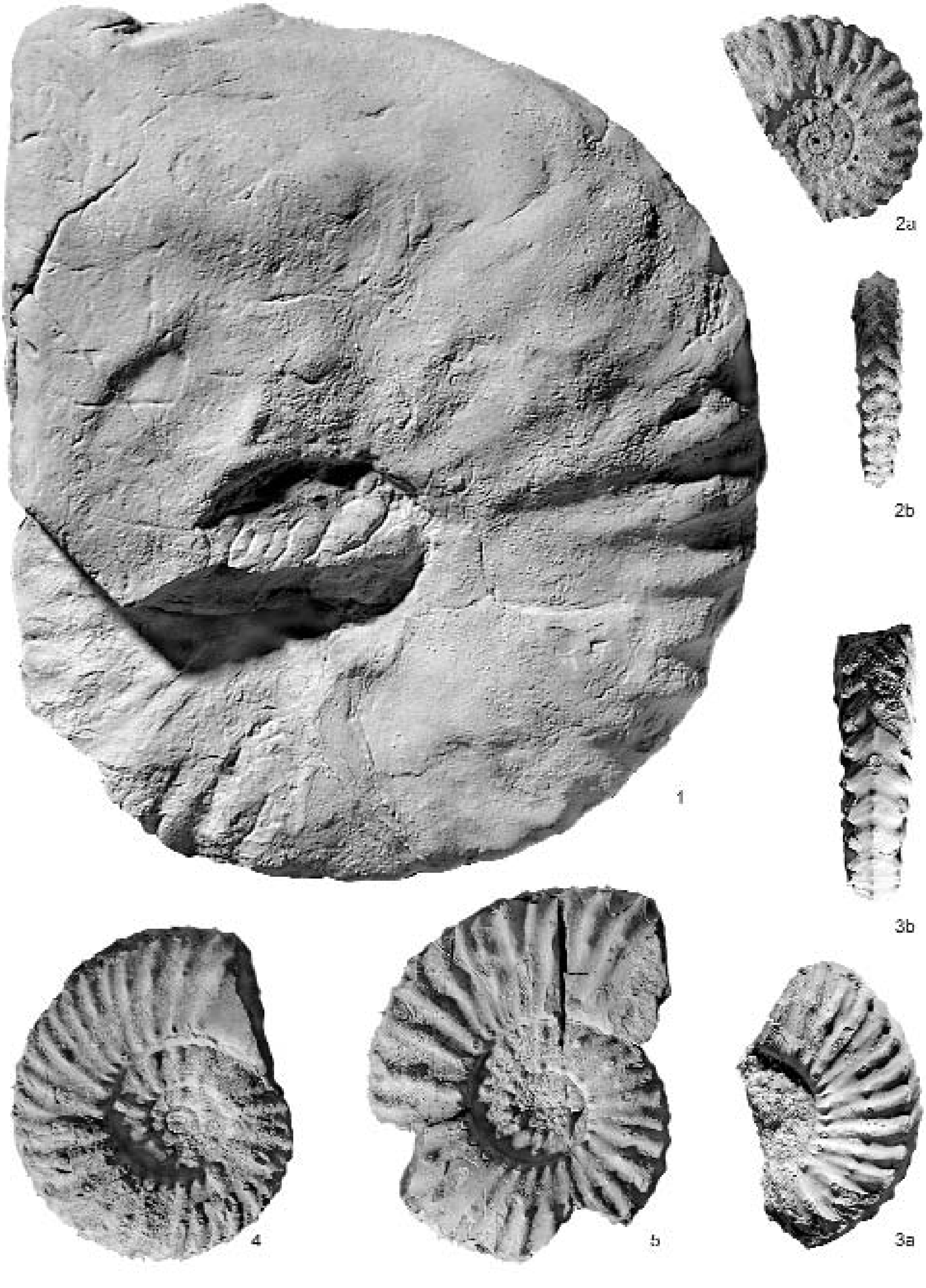
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Plate A-IV.

(All figures in natural size.)

1. *Balatonites balatonicus* (MOJSISOVICS, 1873) — holotype (T.349., GIH), figured in MOJSISOVICS 1873, pl. XIII, figs. 3a–b and in MOJSISOVICS, 1882, pl. IV, figs. 2a–b, (Mencshely, Cser-tető).
2. *Balatonites balatonicus* (MOJSISOVICS, 1873) — 2003.31.1., lateral (a) and ventral (b) views Aszófő II, Bed 5, Balatonicus Zone, Balatonicus Subzone.
3. *Balatonites balatonicus* (MOJSISOVICS, 1873) — 2003.30.1., Aszófő I, Bed 4, Balatonicus Zone, Balatonicus Subzone.
4. *Balatonites balatonicus* (MOJSISOVICS, 1873) — 2003.25.1., left (a) and right lateral (b) views. Szentkirályszabadja, quarry wall, Balatonicus Zone, Balatonicus Subzone.
5. *Balatonites balatonicus* (MOJSISOVICS, 1873) morphotype *zitteli* — 2003.22.1., Aszófő II, Bed 3, Balatonicus Zone, Balatonicus Subzone.

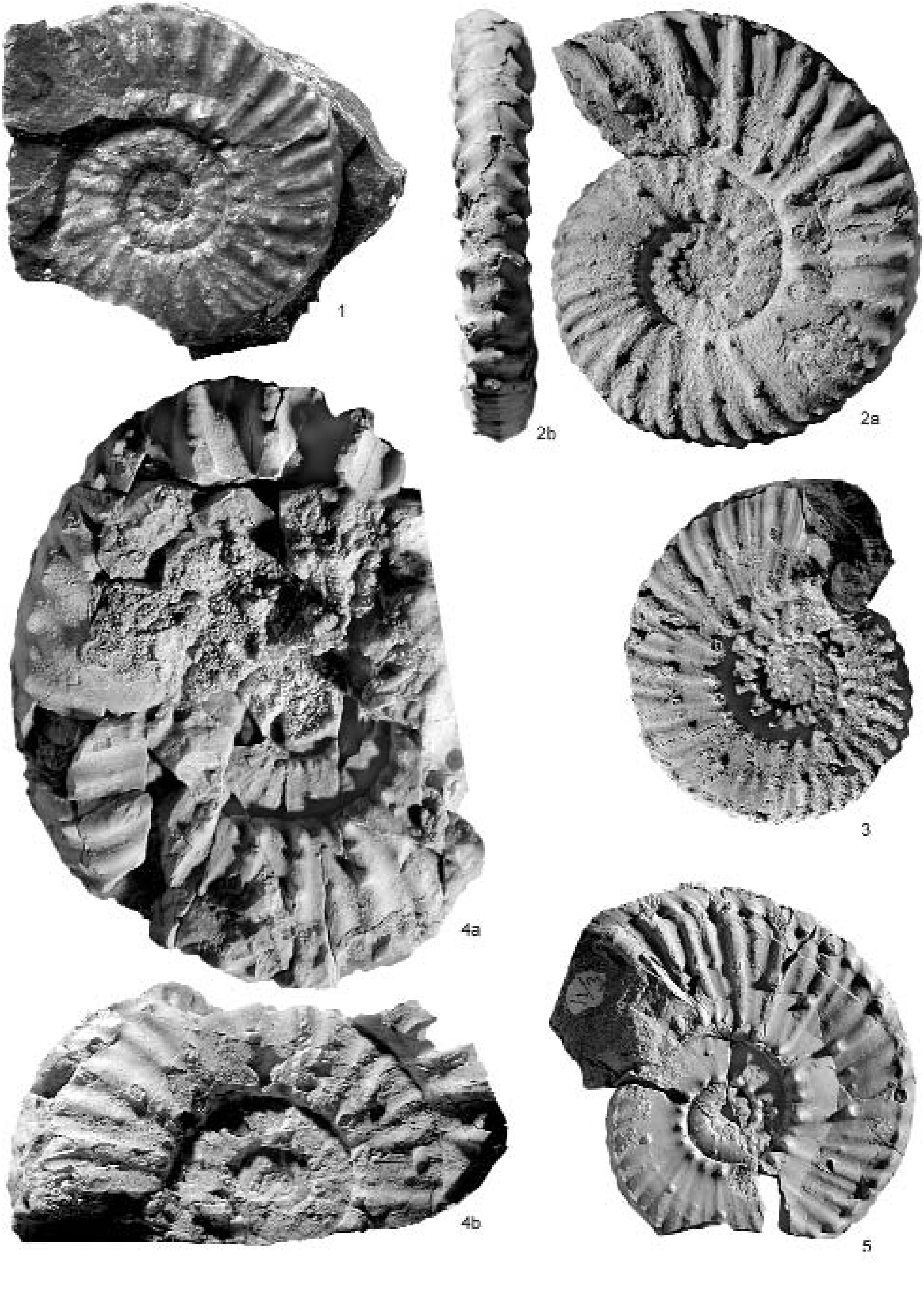
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Plate A-V.
(All figures in natural size.)

1. *Balatonites balatonicus* (MOJSISOVICS, 1873) morphotype *zitteli* — 2003.21.1., Aszófő I, Bed 14, Balatonicus Zone, Cadoricus Subzone.
2. *Balatonites balatonicus* (MOJSISOVICS, 1873) morphotype *zitteli* — 2003.19.1., Aszófő I, Bed 5, Balatonicus Zone, Balatonicus Subzone.
3. *Balatonites balatonicus* (MOJSISOVICS, 1873) morphotype *zitteli* — 2003.20.1., Aszófő II, Bed 3, Balatonicus Zone, Balatonicus Subzone.
4. *Balatonites gemmatus* MOJSISOVICS, 1882 — 2003.23.1., Aszófő II, Bed 19, Balatonicus Zone, Balatonicus Subzone.
5. *Balatonites gemmatus* MOJSISOVICS, 1882 — 2003.24.1., Aszófő II, Bed 17, Balatonicus Zone, Balatonicus Subzone.
6. *Balatonites* cf. *gemmatus* MOJSISOVICS, 1882 — M.89.31, lateral (a) and ventral (b) views. Veszprém, Szabadság-puszta, Balatonicus Zone, Balatonicus(?) Subzone.
7. *Balatonites egregius* ARTHABER, 1896, morphotype *jovis* — 2003.39.1., lateral (a) and ventral (b) views. Mencshely (Cser-tető III), Bed 22, Balatonicus Zone, Balatonicus Subzone.
8. *Balatonites egregius* ARTHABER, 1896, morphotype *jovis* — 2003.35.1., Aszófő II, Bed 40, Ismidicus Zone, Ottonis Subzone.
9. *Balatonites egregius* ARTHABER, 1896, morphotype *jovis* — 2003.37.1., Aszófő II, Bed 5, Balatonicus Zone, Balatonicus Subzone.
10. *Balatonites egregius* ARTHABER, 1896, morphotype *jovis* — 2003.38.1., Aszófő I, Bed 3, Balatonicus Zone, Balatonicus Subzone.
11. *Balatonites egregius* ARTHABER, 1896, morphotype *jovis* — 2003.36.1., Aszófő II, Bed 18, Balatonicus Zone, Balatonicus Subzone.


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Plate A-VI.
(All figures in natural size.)

1. *Bulogites zoldianus* (MOJSISOVICS, 1882) — 2003.43.1., left lateral (a) ventral (b) and right lateral (c) views. Aszófő I, Bed 79, Balatonicus Zone, Zoldianus Subzone.
2. *Bulogites gosaviensis* (MOJSISOVICS, 1882) — 2003.40.1., Aszófő I, Bed 60, Balatonicus Zone, Zoldianus Subzone.
3. *Bulogites multinodosus* (HAUER, 1892) — 2003.42.1., Aszófő I, Bed 67, Balatonicus Zone, Zoldianus Subzone.
4. *Bulogites multinodosus* (HAUER, 1892) — 2003.41.1., Aszófő I, Bed 61, Balatonicus Zone, Zoldianus Subzone.
5. *Bulogites mojsvari* (ARTHABER, 1896) — 2003.44.1., Aszófő I, Bed 70, Balatonicus Zone, Zoldianus Subzone.
6. *Bulogites mojsvari* (ARTHABER, 1896) — 2003.46.1., left lateral (a) ventral (b) and right lateral (c) views.Aszófő I, Bed 71, Balatonicus Zone, Zoldianus Subzone.
7. *Bulogites mojsvari* (ARTHABER, 1896) — 2003.47.1., Aszófő I, Bed 61, Balatonicus Zone, Zoldianus Subzone.
8. *Bulogites mojsvari* (ARTHABER, 1896) — 2003.45.1., Aszófő I, Bed 62, Balatonicus Zone, Zoldianus Subzone.

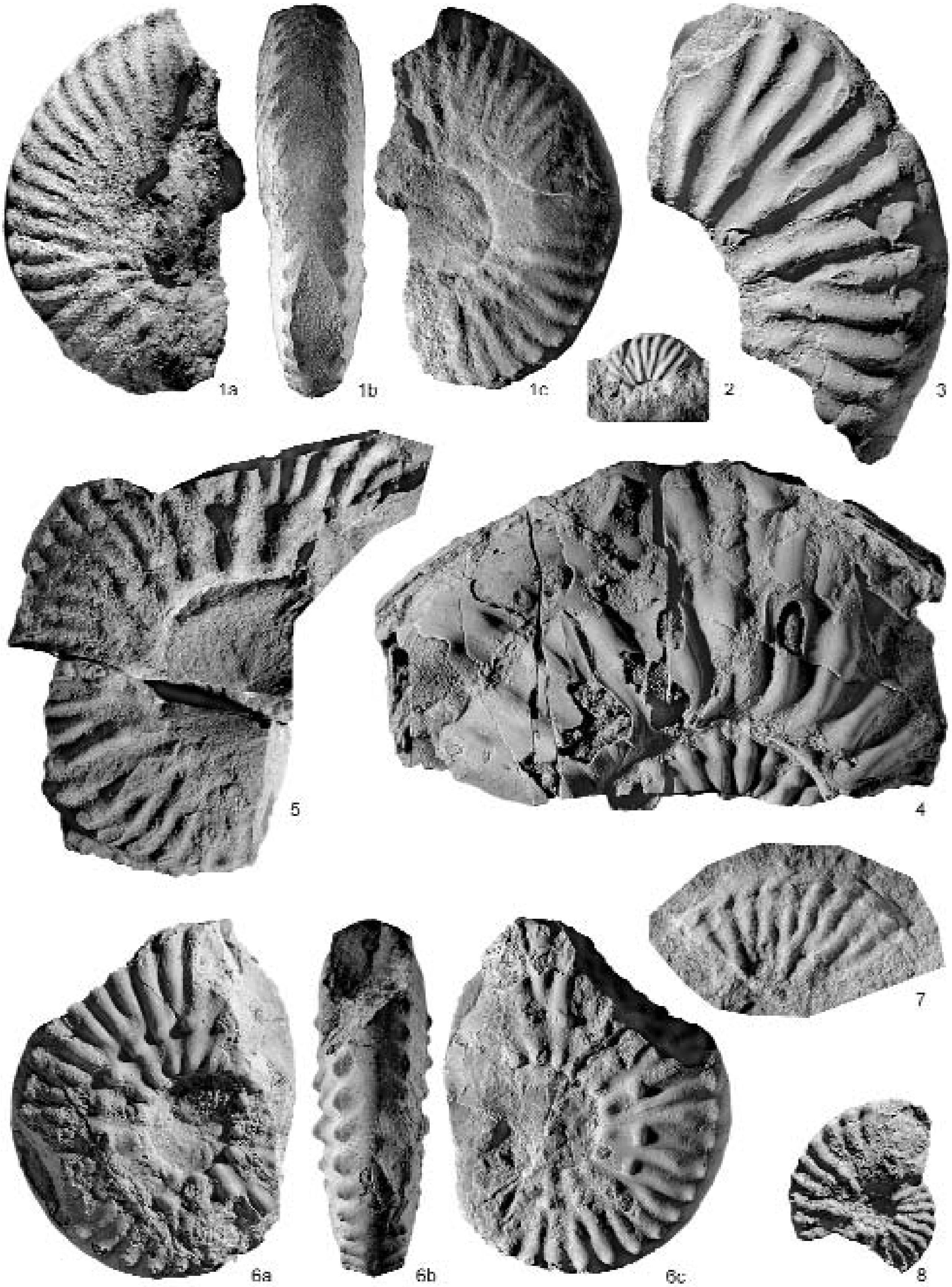
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Plate A-VII.

(All figures in natural size.)

1. *Ismidites* cf. *marmarensis* ARTHABER, 1915 — 2003.49.1., lateral (a) and ventral (b) views. Aszófő I, Bed 13, Balatonicus Zone, Cadoricus Subzone.
2. *Ismidites* cf. *marmarensis* ARTHABER, 1915 — 2003.50.1., lateral (a) and ventral (b) views. Aszófő II, Bed 6, Balatonicus Zone, Balatonicus Subzone.
3. *Alanites* ? sp. — 2003.51.1., Aszófő I, Bed 14, Balatonicus Zone, Cadoricus Subzone.
4. *Beyrichites beneckei* (MOJSISOVICS 1882) — 2003.58.1., Aszófő I, Bed 87, Balatonicus Zone, Zoldianus Subzone.
5. *Beyrichites beneckei* (MOJSISOVICS, 1882) — 2003.52.1., ventral (a) and lateral (b) views. Aszófő I, Bed 17, Balatonicus Zone, Cadoricus Subzone.
6. *Beyrichites cadoricus* (MOJSISOVICS, 1869) — 2003.55.1., Aszófő I, Bed 15, Balatonicus Zone, Cadoricus Subzone.
7. *Beyrichites cadoricus* (MOJSISOVICS, 1869) — 2003.54.1., Aszófő I, Bed 9, Balatonicus Zone, Cadoricus Subzone.
8. *Beyrichites cadoricus* (MOJSISOVICS, 1869) — 2003.53.1., Aszófő I, Bed 11, Balatonicus Zone, Cadoricus Subzone.
9. *Beyrichites cadoricus* (MOJSISOVICS, 1869) — 2003.56.1., Aszófő I, Bed 15, Balatonicus Zone, Cadoricus Subzone.
10. *Beyrichites* cf. *reuttensis* (BEYRICH, 1867) — 2003.57.1., Aszófő I, Bed 90, Balatonicus Zone, Binodosus Subzone.
11. *Beyrichites* ? sp. — 2003.66.1., Aszófő I, Bed 90, Balatonicus Zone, Binodosus Subzone..
12. *Ismidites* sp., aff. *marmarensis* ARTHABER, 1915 — 2003.48.1., ventral (a) and lateral (b) views. Aszófő II, Bed 18, Balatonicus Zone, Balatonicus Subzone.
13. *Schreyerites ragazzonii* (MOJSISOVICS, 1882) — 2003.60.1., Aszófő I, Bed 80, Balatonicus Zone, Zoldianus Subzone.
14. *Schreyerites ragazzonii* (MOJSISOVICS, 1882) — 2003.62.1., Aszófő I, Bed 84, Balatonicus Zone, Zoldianus Subzone.
15. *Schreyerites ragazzonii* (MOJSISOVICS, 1882) — 2003.69.1., Mencshely (Cser-tető III), Bed 9, Balatonicus Zone, Binodosus Subzone.
16. *Schreyerites ragazzonii* (MOJSISOVICS, 1882) — 2003.61.1., Aszófő I, Bed 76, Balatonicus Zone, Zoldianus Subzone.

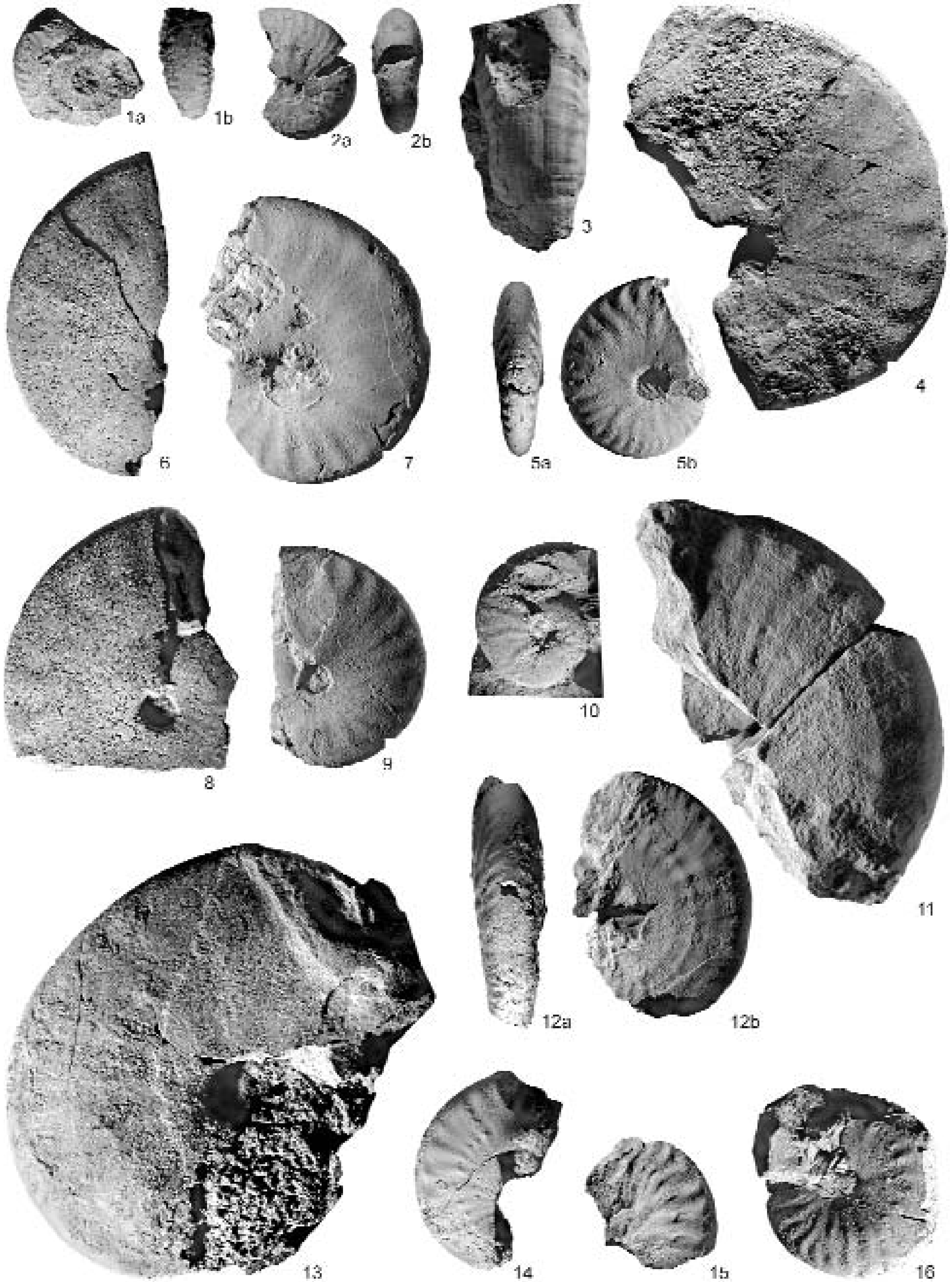
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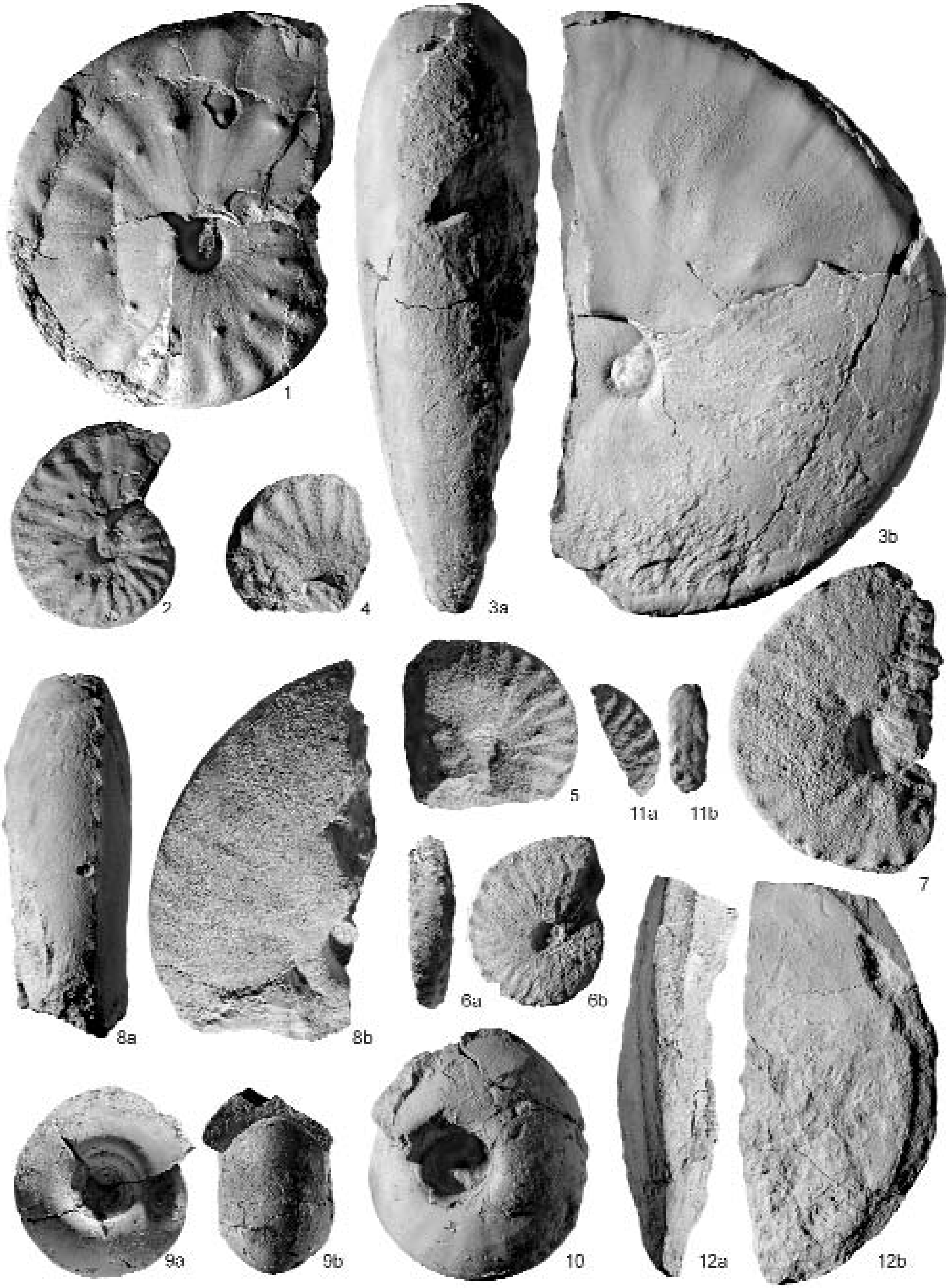
Plate A-VIII.

(All figures in natural size.)

1. *Schreyerites loretzi* (MOJSISOVICS, 1882) — 2003.59.1., Aszófő I, Bed 8, Balatonicus Zone, Cadoricus Subzone.
2. *Schreyerites loretzi* (MOJSISOVICS, 1882) — 2003.65.1., Aszófő I, Bed 13, Balatonicus Zone, Cadoricus Subzone.
3. *Schreyerites* sp., aff. *splendens* ARTHABER, 1896 — 2003.71.1., ventral (a) and lateral (b) views. Aszófő I, Bed 15, Balatonicus Zone, Cadoricus Subzone.
4. *Schreyerites* ? *binodosus* (HAUER, 1851) — 2003.63.1, Mencshely (Cser-tető III), Bed 9, Balatonicus Zone, Binodosus Subzone.
5. *Schreyerites* ? *binodosus* (HAUER, 1851) — 2003.70.1., Aszófő I, Bed 90, Balatonicus Zone, Binodosus Subzone.
6. *Schreyerites* ? *binodosus* (HAUER, 1851) — 2003.68.1., ventral (a) and lateral (b) views. Felsőörs, loose (around Bed 82), Balatonicus Zone, Binodosus Subzone.
7. *Schreyerites* ? *binodosus* (HAUER, 1851) — 2003.64.1., Felsőörs, Bed 72, Balatonicus Zone, Binodosus Subzone.
8. *Semiornites* sp. — 2003.67.1., ventral (a) and lateral (b) views. Felsőörs, Bed 78, Balatonicus Zone, Binodosus Subzone.
9. *Discoptychites domatus* (HAUER, 1851) — 2003.73.1., lateral (a) and ventral (b) views. Aszófő I, Bed 3, Balatonicus Zone, Balatonicus Subzone.
10. *Discoptychites domatus* (HAUER, 1851) — 2003.74.1, Aszófő I, loose (around Bed 3), Balatonicus Zone, Balatonicus Zone.
11. *Judicarites* cf. *euryomphalus* (BENECKE, 1865) — M.2001.34., lateral (a) and ventral (b) views. Köveskál (Horog-hegy), Bed I/1, Balatonicus Zone, Binodosus Subzone.
12. *Noetlingites* sp. – 2003.75.1., ventral (a) and lateral (b) views. Aszófő II, Bed 17, Balatonicus Zone, Balatonicus Subzone.


1
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THE PELSONIAN BIVALVIA FAUNA OF THE BALATON HIGHLAND

István Szente & Attila Vörös

INTRODUCTION

The Triassic of the Balaton Highland entered the limelight of international palaeontological interest following the publication of a series of papers which were issued as parts of the “Balaton monographs” (Resultaten der Wissenschaftlichen Erforschung des Balatonsees) initiated by L. Lóczy Senior. The “Palaeontological Supplements”, written by well-known experts of the last decades of the 19th century, well document the relative abundance of different fossil groups encountered. Macrofossil assemblages of the Pelsonian rocks were found to be dominated by ammonites and brachiopods which have attracted repeated palaeontological interest since the last decades of the 19th century (see Vörös, this volume and Pálfy, this volume, respectively).

Except of some „paper pectens”, such as *Daonella* and *Posidonia* occurring in rock-forming quantities in some beds, bivalves are relatively rare in the Pelsonian strata and information on them is rather scattered in the literature. Although the most frequent forms comprising about a dozen of species were described and figured by Mojsisovics (1874), Bittner (1901), Frech (1904, 1907), and Kittl (1912), the fauna has not been treated in a comprehensive manner.

In the course of the geological mapping and the National Geological Key Section Programme, performed by the Geological Institute of Hungary in the last two decades, a large amount of bivalves were collected at the Balaton Highland, providing a good basis for studying this relatively neglected group. A preliminary faunal list of the rich bivalve fauna of the upper part of the Aszófő section was published by Vörös (1987).

Thanks are due to Drs Géza Császár and Tamás Budai who initiated and continuously supported our work and kindly made the material available for study. The authors profited from the discussions with Dr. Ana Márquez-Aliaga. The help of the late Lajos Dosztály, József Pálfy, and Imre Szabó is also gratefully acknowledged herein. The present study was supported by the grants T26278 and T43325 of the Hungarian Scientific Research Fund (OTKA).

LOCALITIES

The fauna described here has been collected from the Felsőörs Formation, which is comprising mainly limestones deposited in deeper sublitoral, basinal environments (for details of stratigraphy and palaeogeography see a previous chapter “Stratigraphy” of this volume).

Three exposures of the Felsőörs Formation were found to contain bivalve fossils. (Figure Biv-1). The Aszófő section yielded a very rich

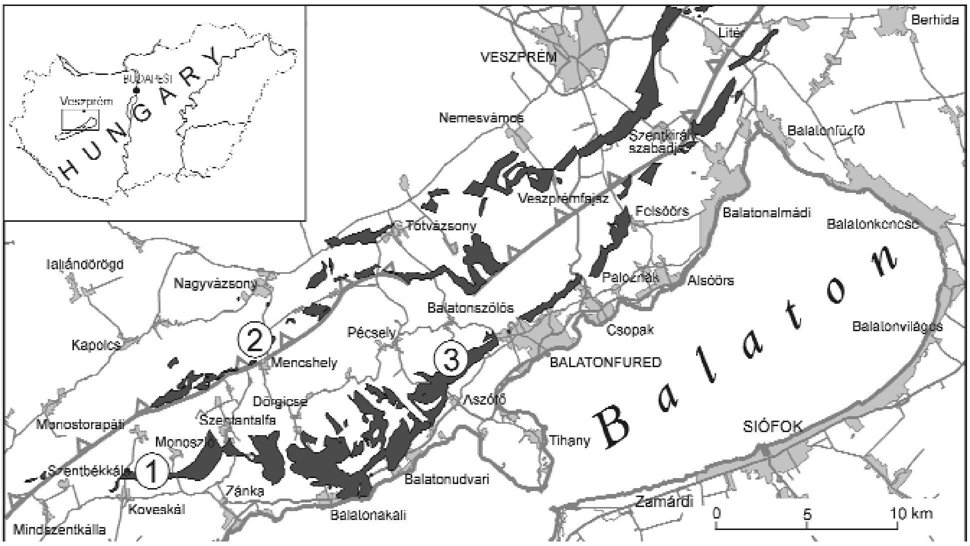

Figure Biv-1. Situation map showing the most important sections and localities of the Balaton Highland providing Pelsonian bivalves. The distribution of Pelsonian formations is shown dark shaded (barbed line marks the Litér overthrust)

1 — Köveskál, Horog-hegy; 2 — Mencshely, Cser-tető; 3 — Aszófő

material (see VÖRÖS 1987 for preliminary results). A poorly preserved, but relatively diverse assemblage was found at the Horog-hegy locality near the village of Köveskál (see VÖRÖS & PÁLFY 2002) while the Cser-tető III section near Mencshely yielded a less diverse faunula.

THE FAUNA

More than 1700 specimens have been available for study excluding *Daonella* and *Posidonia* which were encountered in rock-forming quantities. The complete faunal list:

Palaeoneilo praecursor (FRECH, 1904)
"Palaeoneilo" minutissima (FRECH, 1904)
Solemya abbreviata (FRECH, 1904).
Mysidiella ? sp.
Protopis cf. *waageni* (SCHNETZER, 1934)
Protopis ? sp.
Septifer ? sp.
Parallelodon sp.
Bakevellia (*B.*) *binneyi* (BROWN, 1841)
Bakevellia sp.
Gervillaria cf. *hartmanni* (MÜNSTER, 1834)
Cassianella praecursor FRECH, 1904
Cassianella sp.
Posidonia wengensis (WISSMANN, 1841)
Limea (Pseudolimea ?) sp.
Mysidioptera ? sp.
Plagiostoma striatum (SCHLOTHEIM, 1820)
Plagiostoma sp.
Serania ? sp.
Limidae ? gen. et sp. indet.
Leptochondria cf. *viezzenensis* (WILCKENS, 1909)
Leptochondria ? sp. A
Leptochondria ? sp. B
Newaagia ? sp.
Daonella (D.) boeckhi MOJSISOVICS, 1874
Pleuronectites laevigatus SCHLOTHEIM, 1820
Entolium discites (SCHLOTHEIM, 1820)
Entolium cf. *kellneri* (KITTL, 1903)
Entolioides ? sp.
Unionites subrectus (BITTNER, 1901)
Myophoria cf. *proharpa* FRECH, 1904
Schafhaeutlia ? sp.
Myoconcha (*Pseudomyoconcha*) ? sp.
Pseudocorbula gregaria (MÜNSTER in GOLDFUSS, 1838)
Pleuromya elongata (SCHLOTHEIM, 1822)

Most of the bivalve remains are internal molds with remnants of shell. Internal features could be studied only in a very few cases. The unfavourable state of preservation allowed usually tentative identifications. The material has been kept at the Geological and Palaeontological Department of the Hungarian Natural History Museum (HNHM).

SYSTEMATIC DESCRIPTIONS

In the following a brief systematic account of bivalves of the type Pelsonian is given, arranged according to the synoptical classification of AMLER (1999). The material has been collected from the Balatonicus Zone of the Aszófő section unless otherwise indicated.

Subclass Palaeotaxodonta KOROBKOV, 1954 (NEWELL, 1965)
Order Nuculoida DALL, 1889

Genus **Palaeoneilo** HALL & WHITFIELD, 1869
Palaeoneilo praecursor **(FRECH, 1904)**
Plate Biv-I, 1–6.

v 1904 *Ctenodonta elliptica* GOLDF. sp. mut. nov. *praecursor* — FRECH, p. 11, text-fig. 9b.
v 1987 *Palaeoneilo praecursor* (FRECH, 1904) — VÖRÖS, p. 54.
v 1987 *Palaeoneilo* sp. — VÖRÖS, p. 55.

Material: 121 specimens, many of them closed double-valves filled with sparry calcite.

Description: Small-sized (up to 10 mm long), moderately inflated shells with elliptical outline and umbones placed at about the third fifth of the length.

Remarks: P. praecursor differs from the Carnian – Lower Jurassic species *P. elliptica* (GOLDFUSS, 1838) (see BITTNER 1895, pl. 16, figs 26–31; FARSAN 1975, pl. 1, fig. 1; HODGES 2000, pl. 2, figs 1–30) by its more anteriorly placed umbones as well as by its abrupted dorsal margin forming an obtuse angle.

"Palaeoneilo" minutissima **(FRECH, 1904)**
Plate Biv-I, 7.

v 1904 *Ctenodonta lineata* Gf. sp. mut. nov. *minutissima* — FRECH, p. 13, text-fig. 10.
v 1987 *Palaeoneilo minutissima* (FRECH, 1904) — VÖRÖS, p. 54.

Material: 3 specimens.

Description: Small-sized (up to 10 mm long), trapezoidal form with an obtuse posterior rostrum well demarcated from the inflated body.

Remarks: FRECH (1904) compared three minute valves collected from the "Muschelkalk" cropping out near the town of Veszprém to the Carnian species *P. lineata* (GOLDFUSS) (see BITTNER 1895, pl. 16, figs 1–16). The Balaton Highland specimens, however, considerably differ in shape from *P. lineata* as well as from other species of *Palaeoneilo* and the presence of the well-defined rostrum may indicate anomalodesmatan affinities as well. Since internal features can not be studied, generic assignment of *"P."* *minutissima* has remained uncertain.

Subclass Lipodonta (IREDALE, 1939) COPE, 1995
Order Solemyoida DALL, 1889
Family Solemyidae (ADAMS & ADAMS 1857) GRAY, 1840

Genus **Solemya** LAMARCK, 1818
Solemya abbreviata **(FRECH, 1904)**
Plate Biv-I, 8–10.

v 1904 *Solenomya abbreviata* n. sp. — FRECH, p. 19, text-fig. 20.
1923 *Solenomya abbreviata* FRECH — DIENER, p. 229.
v 1987 *Solemya abbreviata* (FRECH, 1904) — VÖRÖS, p. 54.
v 2002 *Solemya abbreviata* (FRECH, 1904) — VÖRÖS & PÁLFY, p. 55.

Material: A single specimen from Köveskál Horog-hegy and 254 specimens, all internal molds, from Aszófő.

Description: Small-sized (up to 25 mm long), elongated form with rounded outline and umbones placed at about the third fifth of the length. The specimens bear dense radial striae.

Remarks: S. abbreviata differs from the similar Carnian species *S. semseyana* (BITTNER 1901, pl. 8, figs 21–24) by its less truncated anterior margin.

Subclass Pteriomorphia BEURLEN, 1944
Order Mytiloida FÉRUSSAC, 1822
Family Mysidiellidae COX, 1964

Genus **Mysidiella** COX, 1964
Mysidiella **? sp.**
Plate Biv-I, 14.

Material: A single, fragmentary internal mold of a left valve.

Description: Small-sized, higher than long, ovate form with strongly protruding, slightly prosogyrous umbo.

Remarks: The general form of the specimen recalls *Mysidiella* rather than any other genus. The state of preservation does not allow, however, a more precise identification.

Genus **Protopis** KITTL, 1904
***Protopis* cf. *waageni* (SCHNETZER, 1934)**
Plate Biv-I, 13.

cf. 1934 *Joannina waageni* n. sp. — SCHNETZER, p. 28, pl. 1, figs 2-5.
1967 *Joannina waageni* SCHNETZER — CASATI & GNACCOLINI, p. 128, pl. 11, figs 1, 2; text-fig. 33.
cf. 1967 *Joannina waageni* SCHNETZER — SPECIALE, p. 1097, pl. 81, fig. 33.
v 2002 *Hoernesia* sp. — VÖRÖS & PÁLFY, p. 55.

Material: Internal mold of a single left valve from Köveskál (Horog-hegy).
Description: Relatively large (30 mm long), trapezoidal form with a prominent keel running from the umbo to the posteroventral corner. The antero-ventral part is lacking, thus the anterior auricle can not be studied.
Remarks: The Horog-hegy specimen differs from the type and from the specimen figured by SPECIALE (1967) by its less inflated shape and closely resembles the specimen figured by CASATI & GNACCOLINI (1967).

***Protopis* ? sp.**
Plate Biv-I, 12.

Material: Three specimens from Aszófő.
Description: Trapezoidal shell with a blunt keel running from the umbo to the postero-ventral corner.
Remarks: The shape of the specimens recalls *Protopis*. Since internal features can not be studied, their attribution to Mysidiellidae instead of Opinae CHAVAN, 1942 (subclass Heteroconchia) remains largely uncertain.

Family Septiferidae SCARLATO & STAROBOGATOV, 1979

Genus **Septifer** RECLUZ, 1848
***Septifer* ? sp.**

Remarks: About ten small-sized (up to 10 mm high) mytiliform internal molds from Köveskál (Horog-hegy) and Aszófő are assigned, although doubtfully, to *Septifer*.

Order Arcoida STOLICZKA, 1871
Family Parallelodontidae DALL, 1898

Genus **Parallelodon** MEEK & WORTHEN, 1866
***Parallelodon* sp.**
Plate Biv-I, 11.

Material: Six incomplete internal molds.
Remarks: The general shape of the specimens recalls *Parallelodon* rather than other arcoid genera. Features of the hinge, however, could not be studied thus the generic position is somewhat uncertain.

Order Pterioida NEWELL, 1965
Family Bakevelliidae KING, 1850

Genus **Bakevellia** KING, 1850
***Bakevellia (Bakevellia) binneyi* (BROWN, 1841)**
Plate Biv-I, 16–19.

v 1987 *Bakevellia* sp. — VÖRÖS, p. 55.
1995 *Bakevellia (B.) binneyi* (BROWN, 1841) — MUSTER, p. 31, text-figs. 22-23, pl. 3, figs 5-7; pl. 4, figs 1–7 (cum syn.).

Material: 77 specimens.
Description: Medium-sized (up to 30 mm high) rhomb-shaped shell with inflated body meeting the dorsal margin at an angle of about 35–40°. Anterior ear rounded, posterior wing obtuse.
Remarks: The taxonomy of Bakevellidae was discussed recently in detail by MUSTER (1995) whose species concept is shared herein regarding the Balaton Highland specimens as representatives of the variable species *B.* (*B.*) *binneyi* [= *Bakevellia costata* (SCHLOTHEIM, 1820)].

Genus **Gervillaria** Cox, 1951
***Gervillaria* cf. *hartmanni* (Münster, 1834)**
Plate Biv-I, 15.

cf. 1834 *Gervillia hartmanni* Münster — Münster in Goldfuss, p. 122, pl. 115, figs 7a–f.
v 1987 *Bakevellia* sp. — Vörös, p. 55 (partim).
cf. 1995 *Gervillaria hartmanni* Münster — Muster, p. 56, pl. 9, figs 3–5, pl. 10, figs 1-2, text-fig 40.

Remarks: A single, poorly-preserved specimen from Aszófő seems to differ from other bakevelliids encountered and resembles the essentially Jurassic species *G. hartmanni*, which were identified from the Middle Triassic by Muster (1995).

Family Cassianellidae Ichikawa, 1958

Genus **Cassianella** Beyrich, 1862
***Cassianella praecursor* Frech, 1904**
Plate Biv-I, 20–22.

v 1904 *Cassianella ampezzana* Bittner mut. nov. *praecursor* — Frech, p. 17, text-fig. 16.
v 1987 *Cassianella praecursor* Frech — Vörös, p. 55.

Material: 113 left valves.
Description: Minute (up to 5 mm high), relatively inflated smooth shells with well-developed anterior and posterior wings. Length slightly exceeds height.
Remarks: C. praecursor differs from other *Cassianella* species by its body almost perpendicular to the straigth dorsal margin as well as by its smooth surface. The very faint radial striae mentioned by Frech (1904) can not be seen in the Aszófő specimens.

***Cassianella* sp.**

v 2002 *Cassianella* ? sp. — Vörös & Pálfy, p. 55.

Material: A single incomplete internal mold of a left valve from Köveskál (Horog-hegy).
Description: About 15 mm high valve, displaying *Cassianella*-like form and bearing a very shallow radial depression.
Remarks: The specimen differs from *C. praecursor* by its larger size as well as by its, although very weak, ornamentation.

Family Posidoniidae Frech, 1909

Genus **Posidonia** Bronn, 1828
***Posidonia wengensis* (Wissmann, 1841)**
Plate Biv-I, 27, 28.

1841 *Posidonomya Wengensis* Wissm. — Wissmann, p. 23, pl. 6, fig. 12.
1912 *Posidonomya wengensis* Wissm. — Kittl, p. 18, pl. 1, figs 6-12.
v 1987 *Posidonia wengensis* (Wissmann, 1841) — Vörös, p. 55.
2001 *Posidonia* cf. *wengensis* (Wissmann, 1841) — Stiller, p. 274.

Material: Mass in pavements in Aszófő and Mencshely (Cser-tető III).
Description: Small-sized, ovate to subcircular shells with submedially situated, occassionaly pointed umbones and concentric rugae.
Remarks: Due to the unfavourable state of preservation of the material, study of the Aszófő specimens can not contribute to the knowledge of this widespread form.

Order Limoida (Rafinesque, 1815) Waller, 1978
Family Limidae Rafinesque, 1815

Genus **Limea** Bronn, 1831
Subgenus **Pseudolimea** Arkell & Douglas in Arkell, 1932
***Limea (Pseudolimea ?)* sp.**
Plate Biv-II, 3.

Material: Three incomplete specimens.
Description: Medium-sized (16 mm high), ovate shell bearing approx. 20 narrow radial plicae.
Remarks: The shape and ornamentation of the specimens recall *Limea* and probably *Pseudolimea*. The state of preservation, however, does not allow more precise identification.

Genus **Mysidioptera** SALOMON, 1895
***Mysidioptera* ? sp.**
Plate Biv-I, 29.

Material: Eight specimens from Köveskál, Horog-hegy, 67 specimens from Aszófő.

Description: Large-sized (up to 50 mm high), ovate shells ornamented with narrow radial plicae.

Remarks: The pronouncedly inaequilateral form as well as the style of ornamentation recall *Mysidioptera* rather than any other genus.

Genus **Plagiostoma** J. SOWERBY, 1814
***Plagiostoma striatum* (SCHLOTHEIM, 1820)**
Plate Biv-II, 2.

1820 *Chamites striatus* — SCHLOTHEIM, p. 210.
1823 *Chamites striatus* — SCHLOTHEIM, p. 110, pl. 34, fig. 1.
1923 *Lima (Plagiostoma) striata* v. SCHLOTHEIM — DIENER, p. 107 (cum syn.).
1931 *Lima (Plagiostoma) striata* SCHLOTH. — KUTASSY, p. 328 (cum syn.).
1937 *Lima striata* GOLDFUSS — ASSMANN, p. 49, pl. 10, fig. 14.
1967 *Plagiostoma striatum* (SCHLOTHEIM, 1823) — SPECIALE, p. 1109, pl. 82. fig. 7.
v 1987 *Plagiostoma* sp. — VÖRÖS, p. 55 (partim).
1989 *Plagiostoma striata* (SCHLOTHEIM) — NOLTE, p. 327, pl. 1. fig. 7b.
v 1997 *Plagiostoma striatum* (SCHLOTHEIM, 1823) — SZENTE, p. 417, pl. 2, fig. 6.
2001 *Plagiostoma striatum* (SCHLOTHEIM, 1820) — STILLER, p. 279 (cum syn.).

Material: A single left valve.

Description: Medium-sized, ovate shell ornamented with wide, flat-crested radial plicae. Lunula moderately excavated, auricles not preserved.

Remarks: The Aszófő specimen corresponds well to *P. striatum* described and figured in the literature.

***Plagiostoma* sp.**
Plate Biv-II, 6.

Material: 58 internal moulds with traces of shell.

Description: Large-sized form with height exceeding 50 mm. Anterodorsal and posterodorsal margins straight, ventral margin well rounded. Lunula moderately excavated, outer surface smooth.

Remarks: Due to the lack of diagnostic specific features the specimens are identified as *Plagiostoma* sp.

Genus **Serania** KRUMBECK, 1923
***Serania* ? sp.**
Plate Biv-II, 1.

Material: A single internal mold with traces of shell.

Description: Ovate, elongated form whose length (about 5 cm) well exceeds height. The lunula is relatively shallow, the posterior wing is well demarcated from body.

Remarks: The shape of the specimen recalls *Serania*, previously thought to be restricted to the Upper Triassic of Ceram (Indonesia), but recently recorded from the Upper Triassic of Iran as well (HAUTMANN, 2001b). Since internal features of the Aszófő specimen can not be studied, generic position of this interesting form remains uncertain.

Limidae ? gen et. sp. indet.
Plate Biv-II, 4, 5.

Remarks: Some ten specimens from Aszófő seem to differ from any other taxa encountered. Due to the nature of their preservation only a very tentative identification has been attempted.

Family Leptochondriidae NEWELL & BOYD, 1995

Genus **Leptochondria** BITTNER, 1891
***Leptochondria* cf. *viezzenensis* (WILCKENS, 1909)**
Plate Biv-II, 9–11.

cf. 1909 *Pecten viezzenensis* nov. spec. — WILCKENS, p. 147, pl. 5, figs. 25a, b.
cf. 1923 *Pecten viezzenensis* WILCKENS — DIENER, p. 83.

cf. 1972 *Leptochondria viezzenensis* (WILCKENS, 1909) — ALLASINAZ, p. 259, pl. 31, figs 5–9.
v 1987 *Leptochondria* cf. *elegantula* (BITTNER, 1901) — VÖRÖS, p. 55.

Material: 4 specimens.

Description: Small-sized (up to 6 mm high), suborbicular, equilateral shells whose length slightly exceeds height. Dorsal margin straight, both anterior and posterior auricles well developed. Below the anterior auricle shallow byssal sinus is present. Disc and auricles ornamented with radial costae whose number increases during ontogeny by intercalation of new ones.

Remarks: The Aszófő specimens slightly differ from those of the Ladinian of the Southern Alps by their relatively longer dorsal margin as well as by their shallower byssal sinus.

***Leptochondria* ? sp. A**

Plate Biv-II, 12

Material: Internal mold of an incomplete left valve from Köveskál, Horog-hegy.

Description: Medium-sized, flat form bearing narrow, slightly curved radial costae.

Remarks: The specimen differs from *Leptochondria* ? sp. B (see below) by its larger size as well as by the style of ornamentation. Due to its incompleteness it has been assigned to *Leptochondria* with uncertainty, and its pectinid affinities (especially to the genus *Praechlamys* ALLASINAZ, 1972) can not be excluded.

***Leptochondria* ? sp. B**

Plate Biv-II, 13, 14

v 1987 *Leptochondria* sp. — VÖRÖS, p. 55.

Material: 46 specimens.

Description: Small-sized (up to 13 mm long), ovate, inaequilateral shells whose length slightly exceeds height. The outline is usually rounded except the straight dorsal margin in front of the umbo. Some specimens are ornamented with fine radial striae.

Remarks: Due to the complete lack of diagnostic features the specimens in question are assigned to *Leptochondria* with considerable uncertainty.

Family Prospondylidae PTCHELINTSEV, 1960

Genus **Newaagia** HERTLEIN, 1952

***Newaagia* ? sp.**

Plate Biv-II, 20–22.

Material: Two specimens from Köveskál (Horog-hegy) and a single one from Aszófő.

Description: Medium-sized (up to 5 cm high) form bearing a few, relatively sharp-crested, irregular radial plicae.

Remarks: Due to the complete lack of observable diagnostic characters the specimens in question are very tentatively assigned to *Newaagia* redefined recently by HAUTMANN (2001a).

Family Halobiidae KITTL, 1912

Genus **Daonella** MOJSISOVICS, 1874

Subgenus **Daonella** MOJSISOVICS, 1874

***Daonella (Daonella) boeckhi* MOJSISOVICS, 1874**

Plate Biv-I, 23–26.

1874 *Daonella böckhi* E. v. MOJSISOVICS — MOJSISOVICS, p. 8, pl. 3, fig. 15.
v 1912 *Daonella Böckhi* MOJS. — KITTL, p. 32, pl. 1, figs 3–5.
1923 *Daonella boekhi* (sic!) v. MOJSISOVICS — DIENER, p. 46.
1972 *Daonella böckhi* MOJSISOVICS — SCHOLZ, p. 341, pl. 6, fig. 11.
v 1987 *Daonella boeckhi* MOJSISOVICS, 1874 — VÖRÖS, p. 55.
2001 *Daonella boeckhi* MOJSISOVICS — STILLER, p. 275 (cum syn.).

Material: Mass in pavements.

Description: Medium-sized, flat, ovate shells with umbones placed at the first third of the length. Outer surface ornamented with comarginal rugae and very faint radial striae.

Remarks: Morphology of *D.* (*D.*) *boeckhi* was discussed in detail by MOJSISOVICS (1874) and KITTL (1912). No further data can be added to the knowledge of this species on the basis of the Aszófő material.

Family Pectinidae WILKES, 1810

Genus **Pleuronectites** SCHLOTHEIM, 1820
***Pleuronectites laevigatus* SCHLOTHEIM, 1820**
Plate Biv-II, 7, 8.

1820 *Pleuronectites laevigatus* — SCHLOTHEIM, p. 217.
1923 *Pleuronectites laevigatus* SCHLOTHEIM — DIENER, p. 85 (cum syn.).
1931 *Pleuronectites laevigatus* SCHLOTHEIM, 1822 — KUTASSY, p. 315 (cum syn.).
1972 *Pleuronectites laevigatus* SCHLOTHEIM, 1820 — FARSAN, p. 160, pl. 43, figs. 1a, b. (cum syn.).
v 1987 *Entolium* sp. — VÖRÖS, p. 55 (partim).
1989 *Pleuronectites laevigatus* (SCHLOTHEIM) — NOLTE, p. 326 (as *Pecten laevigatus*), pl. 1, fig 6f.
v 2002 *Entolium* sp. — VÖRÖS & PÁLFY, p. 55.

Material: A right valve from Köveskál (Horog-hegy) and a left valve from Aszófő.

Description: Large-sized (about 40 mm high), suborbicular, inaequilateral, opisthocline shells. Auricles of the left valve not sharply demarcated from the disc. Details of the dorsal part of the right valve can not be studied.

Remarks: Features of *P. laevigatus* have been well discussed in the literature. Study of the poorly-preserved Balaton Highland specimens can not contribute to the knowledge of this very widespread form.

Genus **Entolium** MEEK, 1865
***Entolium discites* (SCHLOTHEIM, 1820)**
Plate Biv-II, 15–17.

1820 *Pleuronectites discites* — SCHLOTHEIM, p. 218.
1923 *Pecten (Entolium) discites* V. SCHLOTHEIM — DIENER, p. 70 (cum syn.).
1931 *Pecten (Entolium) discites* SCHLOTHEIM — KUTASSY, p. 308 (cum syn.).
1972 *Entolium discites* (SCHLOTHEIM, 1820) — FARSAN, p. 168, pl. 43, figs 2-3 (cum syn.).
1972 *Entolium discites* (SCHLOTHEIM, 1820) — ALLASINAZ, pp. 221, 284-287, text-fig. 32, pl. 35. figs. 8-9. (cum syn).
v 1987 *Entolium discites* (SCHLOTHEIM, 1820) — VÖRÖS, p. 55.
v 1997 *Entolium discites* (SCHLOTHEIM, 1820) — SZENTE, p. 417, pl. 2, fig. 10.
2001 *Entolium discites* (SCHLOTHEIM, 1820) — STILLER, p. 286 (cum syn.).

Material: 69 specimens.

Description: Medium-sized (up to 36 mm high), orbicular, equilateral shells with anterior and posterior auricles equal in size and slightly protruding above the hinge line. Umbonal angle about 100°.

Remarks: The Aszófő specimens correspond well to *E. discites* described in the literature.

***Entolium* cf. *kellneri* (KITTL, 1903)**
Plate Biv-II, 18.

? 1903 *Pecten (Entolium) kellneri* — KITTL, p. 709, fig. 36.
? 1923 *Pecten (Entolium) kellneri* KITTL — DIENER, p. 74.
? 1972 *Entolium kellneri* (KITTL, 1903) — ALLASINAZ, p. 290, pl. 36, fig. 6.
v 1987 *Entolium kellneri* (KITTL, 1903) — VÖRÖS, p. 55.

Material: 37 specimens.

Description: Small-sized, equilateral, higher than long shell with an umbonal angle of about 65°. Antero-dorsal and postero-dorsal margins straight, ventral margin well rounded. Auricles of equal size well protruding above the hinge line.

Remarks: *E.* cf. *kellneri* can easily be distinguished from *E. discites* by its peculiar auricles. The Aszófő specimens differ from the types by their larger size and slightly more obtuse umbonal angle.

Genus **Entolioides** ALLASINAZ, 1972
***Entolioides* ? sp.**
Plate Biv-II, 19.

Material: A single incomplete internal mold.

Description: Subcircular, longer than high, flat form with numerous radial costae.

Remarks: The shape and ornamentation of the specimen resemble those of the left valve of *Entolioides* as described and figured by ALLASINAZ (1972) and NEWELL & BOYD (1995).

Subclass Heteroconchia HERTWIG, 1895
Order Modiomorphoida NEWELL, 1969
Family Permophoriidae VAN DE POEL, 1895

Genus **Myoconcha** SOWERBY, 1824
Subgenus **Pseudomyoconcha** ROSSI RONCHETTI & ALLASINAZ, 1966
***Myoconcha (Pseudomyoconcha)* ? sp.**

v 2002 *Myoconcha* ? sp. — VÖRÖS & PÁLFY, p. 55.

Remarks: A very poorly preserved right valve from Köveskál (Horog-hegy) is assigned, although very doubtfully, to *Pseudomyoconcha*.

Order Unionoida STOLICZKA, 1871
Family Trigonodidae MODELL, 1942

Genus **Unionites** WISSMANN, 1841
***Unionites subrectus* (BITTNER, 1901)**
Plate Biv-II, 25, 26.

v 1901 *Anodontophora subrecta* n. sp. — BITTNER, p. 100, pl. 7, figs. 28-30.
1907 *Anodontophora subrecta* BITTNER — FRECH, p. 56, pl. 7, fig. 5.
1923 *Anodontophora subrecta* BITTNER — DIENER, p. 234.
v 1987 *Unionites subrectus* (BITTNER, 1901) — VÖRÖS, p. 55.
v 2002 *Unionites subrectus* (BITTNER, 1901) — VÖRÖS & PÁLFY, p. 55.

Material: A single specimen from Köveskál (Horog-hegy) and 232 specimens from Aszófő.
Description: Medium-sized, strongly elongated, inaequilateral shells with umbones situated near the anterior margin. The posterior and ventral margins form a relatively acute angle of about 80°.
Remarks: The Pelsonian specimens correspond well to the types originated from the Ladinian of the Balaton Highland. *U. subrectus* differs from other congeneric species, such as *U. letticus* (QUENSTEDT), *U. muensteri* (WISSMANN) and *U. brevis* (SCHAUROTH) by its length much exceeding height (see *e.g.* SPARFELD 1980).

Order Trigonioida DALL, 1889
Family Myophoriidae BRONN (1847), 1849

Genus **Myophoria** BRONN in ALBERTI, 1834
***Myophoria* cf. *proharpa* FRECH, 1904**
Plate Biv-II, 23.

? 1904 *Myophoria proharpa* n. sp. — FRECH, p. 17, text-fig. 17.
? 1923 *Myophoria proharpa* FRECH — DIENER, p. 179.
v 1987 *Myophoria* sp. aff. *proharpa* FRECH — VÖRÖS, p. 55.

Material: 7 specimens.
Description: Shell of small size for the genus, trapezoidal in outline, with umbones situated close to the anterior margin and with four radial plicae.
Remarks: The Aszófő specimens differ from *M. proharpa* by the lower number of plicae.

Order Veneroida ADAMS & ADAMS, 1856
Family Fimbriidae NICOL, 1950

Genus **Schafhaeutlia** COSSMANN, 1897
***Schafhaeutlia*? sp.**
Plate Biv-II, 24.

Material: One specimen from Köveskál (Horog-hegy) and two specimens from Aszófő, all internal molds.
Description: Shell of medium size, ovate, with prosogyrous umbones placed near the anterior margin.
Remarks: Due to the complete lack of observable diagnostic features the specimens are assigned to *Schafhaeutlia* very tentatively.

Family Myophoricardiidae CHAVAN in VOKES, 1967

Genus **Pseudocorbula** E. PHILIPPI, 1898

***Pseudocorbula gregaria* (MÜNSTER in GOLDFUSS, 1838)**

Plate Biv-II, 27–29.

1838 *Nucula gregaria* — MÜNSTER in GOLDFUSS, p. 152, pl. 124, fig. 12.
1923 *Pseudocorbula gregaria* GRAF zu MÜNSTER — DIENER, p. 186 (cum syn.).
v 1968 *Nucula* sp. — NAGY, p. 77, pl. 5, fig. 16.
1975 *Pseudocorbula gregaria* (MUENSTER) — FARSAN, p. 132, pl. 2, figs 9–12 (cum syn.).
1986 *Pseudocorbula gregaria* (MÜNSTER in GOLDFUSS, 1838) — MÁRQUEZ ALIAGA *et al.*, p. 218, fig. 4c.
v 1987 *Palaeonucula* sp., aff. *goldfussi* (ALBERTI, 1838) — VÖRÖS, p. 54.
v 1987 *Palaeonucula* sp. — VÖRÖS p. 54.
1992 *Pseudocorbula gregaria* (MÜNSTER) — URLICHS, p. 20, pl.1, fig. 6, text-figs. 9, 10 (cum syn).
1995 *Pseudocorbula gregaria* (MÜNSTER in GOLDFUSS, 1837) — FRENEIX, 143, figs. 1 I, J.
v 1997 *Pseudocorbula gregaria* (MÜNSTER in GOLDFUSS) — SZENTE, p. 415, pl.1, fig. 2.
2002 *Pseudocorbula gregaria* (MÜNSTER, 1837) — NIEMEYER, p. 40.

Material: 42 specimens, often forming monospecific pavements.

Description: Small-sized (up to 10 mm high) subtriangular, inequilateral shell with umbones placed slightly anterior to the half of the length, which latter only slightly exceeds height. Posterior margin truncated.

Remarks: The distinguishing features of *P. gregaria* and other species of *Pseudocorbula* were discussed in detail by URLICHS (1992). The Aszófő specimens correspond well to those of the German Muschelkalk.

Order Pholadomyoida NEWELL, 1965
Family Pleuromyidae DALL, 1900

Genus **Pleuromya** AGASSIZ, 1842

***Pleuromya elongata* (SCHLOTHEIM, 1822)**

Plate Biv-II, 30, 31.

1822 *Myacites elongatus* — SCHLOTHEIM, p. 109, pl. 33, figs. 3a, b.
1921 *Pleuromya elongata* SCHLOTHEIM — BENDER, p. 90, pl. 3, figs 2–3. (cum syn.).
1923 *Pleuromya elongata* V. SCHLOTHEIM — DIENER, p. 236 (cum syn.).
1931 *Pleuromya elongata* SCHLOTHEIM — KUTASSY, p. 421 (cum syn.).
? 1986 *Pleuromya* cf. *elongata* (SCHLOTHEIM, 1822) — MÁRQUEZ-ALIAGA *et al.*, p. 219, fig. 4d.
v 1987 *Pleuromya elongata* (SCHLOTHEIM, 1822) — VÖRÖS, p. 55.
2002 *Pleuromya elongata* (SCHLOTHEIM, 1823) — NIEMEYER, p. 41.

Material: 5 specimens.

Description: Small-sized, elongated form with umbones situated at the first fifth of the length. Surface ornamented with comarginal striae.

Remarks: The Aszófő specimens correspond well to *P. elongata* described in the literature and especially resemble those of the German "Trochitenkalk" as figured by BENDER (1921)

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Plate Biv-I.

1. *Palaeoneilo praecursor* (Frech, 1904) — 2×, Aszófő II, Bed 5, Balatonicus Zone, Balatonicus Subzone.
2. *Palaeoneilo praecursor* (Frech, 1904) — 2×, Aszófő I, Bed 23, Balatonicus Zone, Cadoricus Subzone.
3. *Palaeoneilo praecursor* (Frech, 1904) — 2×, Aszófő II, Bed 5, Balatonicus Zone, Balatonicus Subzone.
4. *Palaeoneilo praecursor* (Frech, 1904) — 2×, Aszófő I, Bed 27, Balatonicus Zone, Cadoricus Subzone.
5. *Palaeoneilo praecursor* (Frech, 1904) — 2×, Aszófő I, Bed 27, Balatonicus Zone, Cadoricus Subzone.
6. *Palaeoneilo praecursor* (Frech, 1904) — 2×, Aszófő I, Bed 23, Balatonicus Zone, Cadoricus Subzone.
7. *"Palaeoneilo" minutissima* (Frech, 1904) — 3×, Aszófő I, Bed 30, Balatonicus Zone, Cadoricus Subzone.
8. *Solemya abbreviata* (Frech, 1904) — 1×, Aszófő I, Bed 69, Balatonicus Zone, Zoldianus Subzone.
9. *Solemya abbreviata* (Frech, 1904) — 2×, Aszófő I, Bed 72, Balatonicus Zone, Zoldianus Subzone.
10. *Solemya abbreviata* (Frech, 1904) — 1×, Aszófő I, Bed 69, Balatonicus Zone, Zoldianus Subzone.
11. *Parallelodon* sp. — 1×, Aszófő II, Bed 19, Balatonicus Zone, Balatonicus Subzone.
12. *Protopis* ? sp. — 2×, Aszófő II, Bed 18, Balatonicus Zone, Balatonicus Subzone.
13. *Protopis* cf. *waageni* (Schnetzer, 1934) — 1×, Köveskál (Horog-hegy IV), Balatonicus Zone, Balatonicus Subzone.
14. *Mysidiella* ? sp. — 1×, Aszófő II, Bed 17, Balatonicus Zone, Balatonicus Subzone.
15. *Gervillaria* cf. *hartmanni* (Münster, 1834) — 2×, Aszófő II, Bed 2, Balatonicus Zone, Balatonicus Subzone.
16. *Bakevellia* (*B.*) *binneyi* (Brown, 1841) — 1×, Aszófő II, Bed 19, Balatonicus Zone, Balatonicus Subzone.
17. *Bakevellia* (*B.*) *binneyi* (Brown, 1841) — 2×, Aszófő I, Bed 40, Balatonicus Zone, Cadoricus Subzone.
18. *Bakevellia* (*B.*) *binneyi* (Brown, 1841) — 1×, Aszófő II, Bed 18, Balatonicus Zone, Balatonicus Subzone.
19. *Bakevellia* (*B.*) *binneyi* (Brown, 1841) — 1×, Aszófő II, Bed 26, Balatonicus Zone, Balatonicus Subzone.
20. *Cassianella praecursor* Frech, 1904 — 3×, Aszófő I, Bed 23, Balatonicus Zone, Cadoricus Subzone.
21. *Cassianella praecursor* Frech, 1904 — 4×, Aszófő I, Bed 9, Balatonicus Zone, Cadoricus Subzone.
22. *Cassianella praecursor* Frech, 1904 — 4×, Aszófő I, Bed 23, Balatonicus Zone, Cadoricus Subzone.
23. *Daonella (D.) boeckhi* Mojsisovics, 1874 — 1×, Aszófő I, Bed 60, Balatonicus Zone, Zoldianus Subzone.
24. *Daonella (D.) boeckhi* Mojsisovics, 1874 — 1×, Aszófő I, Bed 61, Balatonicus Zone, Zoldianus Subzone.
25. *Daonella (D.) boeckhi* Mojsisovics, 1874 — 1×, Aszófő I, Bed 61, Balatonicus Zone, Zoldianus Subzone.
26. *Daonella (D.) boeckhi* Mojsisovics, 1874 — 1×, Aszófő I, Bed 60, Balatonicus Zone, Zoldianus Subzone.
27. *Posidonia wengensis* (Wissmann, 1841) — 1×, Mencshely (Cser-tető III), Bed 12, Balatonicus Zone, Cadoricus Subzone.
28. *Posidonia wengensis* (Wissmann, 1841) — 2×, Aszófő I, Bed 58, Balatonicus Zone, Cadoricus Subzone.
29. *Mysidioptera* ? sp. — 1×, Köveskál (Horog-hegy I), Balatonicus Zone, Zoldianus (?) Subzone.

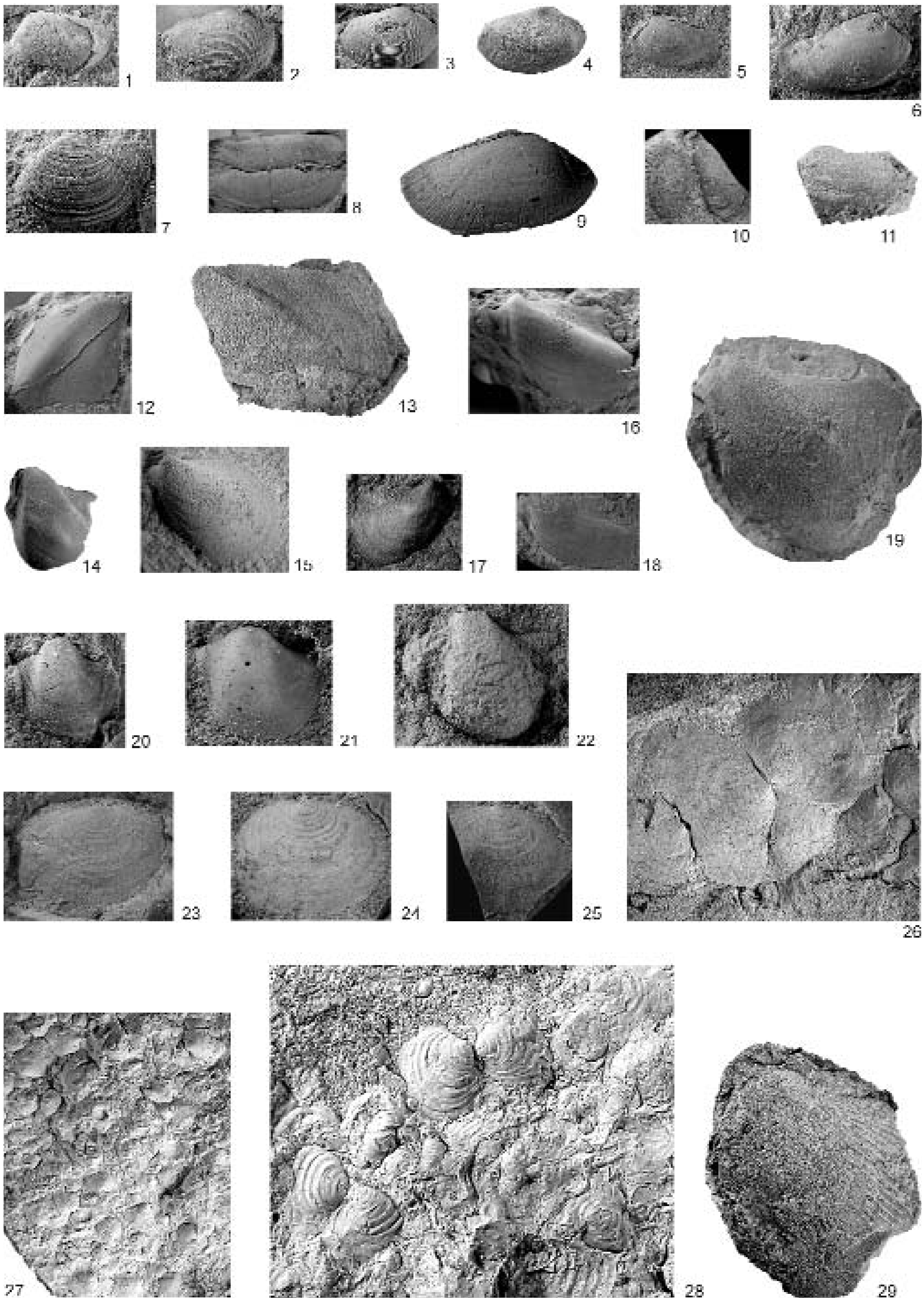
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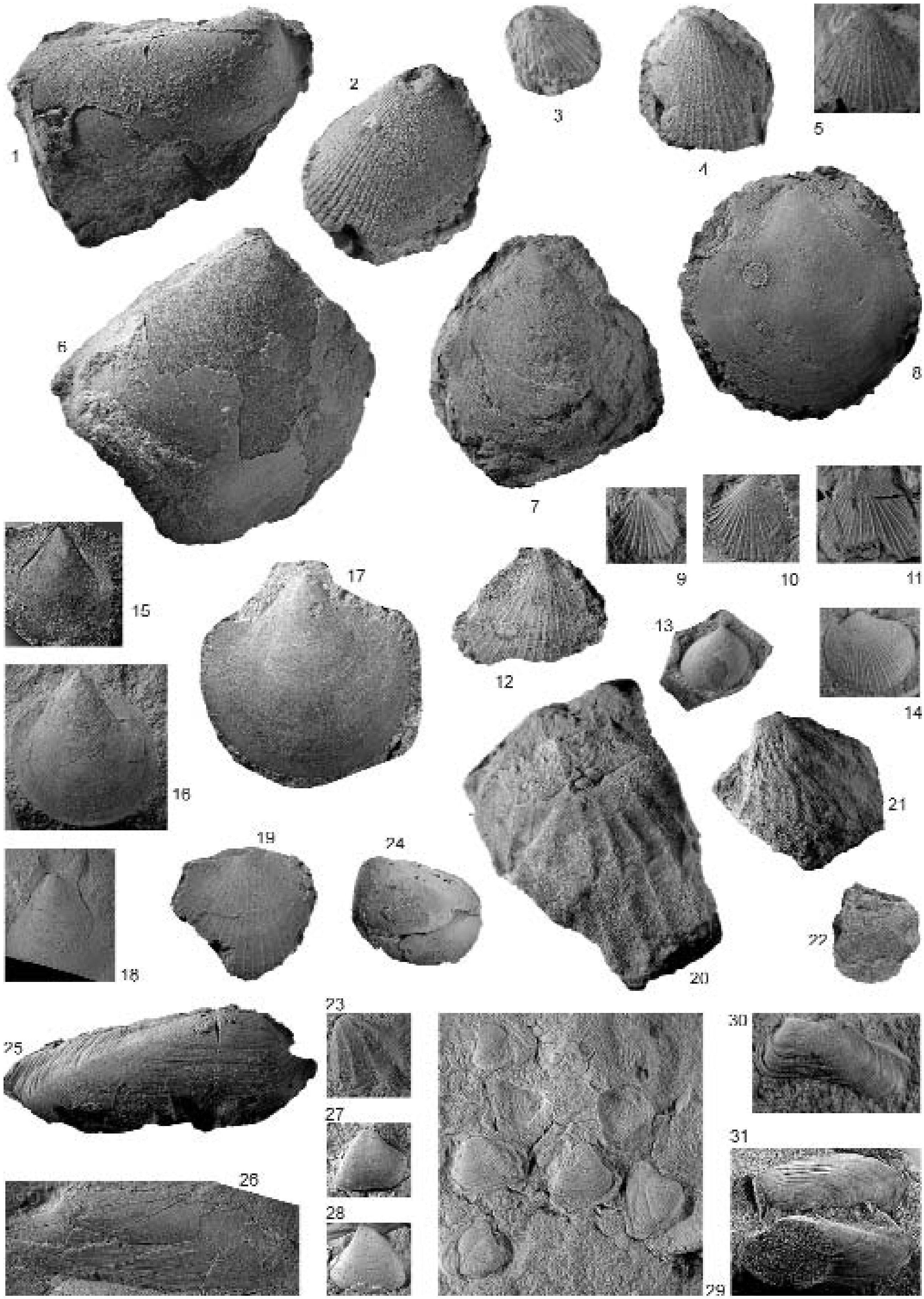
Plate Biv-II.

1. *Serania* ? sp. — 1×, Aszófő II, Bed 18, Balatonicus Zone, Balatonicus Subzone.
2. *Plagiostoma striatum* (Schlotheim, 1820) — 1×, Aszófő II, Bed 18, Balatonicus Zone, Balatonicus Subzone.
3. *Limea (Pseudolimea ?)* sp. — 1×, Aszófő II, Bed 19, Balatonicus Zone, Balatonicus Subzone.
4. *Limidae* ? gen. et sp. indet. — 1×, Aszófő II, Bed 19, Balatonicus Zone, Balatonicus Subzone.
5. *Limidae* ? gen. et sp. indet. — 1×, Aszófő II, Bed 19, Balatonicus Zone, Balatonicus Subzone.
6. *Plagiostoma* sp. — 1×, Aszófő II, Bed 22, Balatonicus Zone, Balatonicus Subzone.
7. *Pleuronectites laevigatus* Schlotheim, 1820 — 1×, Köveskál (Horog-hegy IV), Balatonicus Zone, Balatonicus Subzone.
8. *Pleuronenctites laevigatus* Schlotheim, 1820 — 1×, Aszófő II, Bed 18, Balatonicus Zone, Balatonicus Subzone.
9. *Leptochondria* cf. *viezzenensis* (Wilckens, 1909) — 2×, Aszófő I, Bed 47, Balatonicus Zone, Cadoricus Subzone.
10. *Leptochondria* cf. *viezzenensis* (Wilckens, 1909) — 2×, Aszófő I, Bed 47, Balatonicus Zone, Cadoricus Subzone.
11. *Leptochondria* cf. *viezzenensis* (Wilckens, 1909) — 1×, Aszófő II, Bed 19, Balatonicus Zone, Balatonicus Subzone.
12. *Leptochondria* ? sp. A — 1×, Köveskál (Horog-hegy IV), Balatonicus Zone, Balatonicus Subzone.
13. *Leptochondria* ? sp. B — 1×, Aszófő II, Bed 4, Balatonicus Zone, Balatonicus Subzone.
14. *Leptochondria* ? sp. B — 3×, Aszófő II, Bed 4, Balatonicus Zone, Balatonicus Subzone.
15. *Entolium discites* (Schlotheim, 1820) — 1×, Aszófő I, Bed 27, Balatonicus Zone, Cadoricus Subzone.
16. *Entolium discites* (Schlotheim, 1820) — 2×, Aszófő I, Bed 27, Balatonicus Zone, Cadoricus Subzone.
17. *Entolium discites* (Schlotheim, 1820) — 1×, Aszófő I, Bed 91, Balatonicus Zone, Binodosus Subzone.
18. *Entolium* cf. *kellneri* (Kittl, 1903) — 1×, Aszófő I, Bed 26, Balatonicus Zone, Cadoricus Subzone.
19. *Entolioides* ? sp. — 1×, Aszófő II, Bed 19, Balatonicus Zone, Balatonicus Subzone.
20. *Newaagia* ? sp. — 1×, Köveskál (Horog-hegy IV), Balatonicus Zone, Balatonicus Subzone.
21. *Newaagia* ? sp. — 1×, Köveskál (Horog-hegy IV), Balatonicus Zone, Balatonicus Subzone.
22. *Newaagia* ? sp. — 1×, Aszófő II, Bed 19, Balatonicus Zone, Balatonicus Subzone.
23. *Myophoria* cf. *proharpa* Frech, 1904 — 2×, Aszófő I, Bed 26, Balatonicus Zone, Cadoricus Subzone.
24. *Schafhaeutlia* ? sp. — 1×, Aszófő I, Bed 10, Balatonicus Zone, Cadoricus Subzone.
25. *Unionites subrectus* (Bittner, 1901) — 1×, Aszófő I, Bed 70, Balatonicus Zone, Zoldianus Subzone.
26. *Unionites subrectus* (Bittner, 1901) — 1×, Aszófő I, Bed 77, Balatonicus Zone, Zoldianus Subzone.
27. *Pseudocorbula gregaria* (Münster in Goldfuss, 1838) — 2×, Aszófő II, Bed 5, Balatonicus Zone, Balatonicus Subzone.
28. *Pseudocorbula gregaria* (Münster in Goldfuss, 1838) — 2×, Aszófő II, Bed 5, Balatonicus Zone, Balatonicus Subzone.
29. *Pseudocorbula gregaria* (Münster in Goldfuss, 1838) — 2×, Aszófő I, Bed 42, Balatonicus Zone, Cadoricus Subzone.
30. *Pleuromya elongata* (Schlotheim, 1822) — 2×, Aszófő I, Bed 38, Balatonicus Zone, Cadoricus Subzone.
31. *Pleuromya elongata* (Schlotheim, 1822) — 2×, Aszófő I, Bed 29, Balatonicus Zone, Cadoricus Subzone.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THE PELSONIAN BRACHIOPOD FAUNA OF THE BALATON HIGHLAND

JÓZSEF PÁLFY

INTRODUCTION

Brachiopods are among the most common and diverse fossils in the Pelsonian Substage of the Balaton Highland. The pioneering studies in the second half of the 19th century recognized the "Alpine Muschelkalk" or "Recoaro" limestone based on its distinctive brachiopod faunas, which also permitted correlation with similar facies in the Alps. A detailed history of geological and palaeontological research of Pelsonian strata is given elsewhere (VÖRÖS this volume). The history of brachiopod studies from the Balaton Highland was summarized earlier (PÁLFY 1988).

From the mid-1980's, the author started a revision of the Anisian brachiopod faunas of the Balaton Highland, which included new collecting effort from measured key sections at the localities of Aszófő and Felsőörs, and collection from the poorly exposed locality of Horog-hegy at Köveskál (Figure Br-1). The results were first summarized in Hungarian (PÁLFY 1986), followed by papers on palaeoecological, biostratigraphical and palaeobiogeographical aspects of the Anisian brachiopod faunas (PÁLFY 1991, 1992, 1994). Systematic palaeontological treatment was so far limited to the rhynchonellids (PÁLFY 1988). In the course of geological mapping of the Balaton Highland (BUDAI *et al.* 1999) and ammonoid biostratigraphic studies (VÖRÖS 1998), supplementary collections were obtained from a few other measured sections (Cser-tető at Mencshely and Vörösberény, Figure Br-1). The brachiopod faunula from these localities is of lesser importance. The classic locality of Köveskál was recently revisited and a new excavation was made, resulting in significant new collections from a lower brachiopod-bearing level (referred to as "lower Recoaro" bed) with poor natural outcrops (VÖRÖS & PÁLFY 2002).

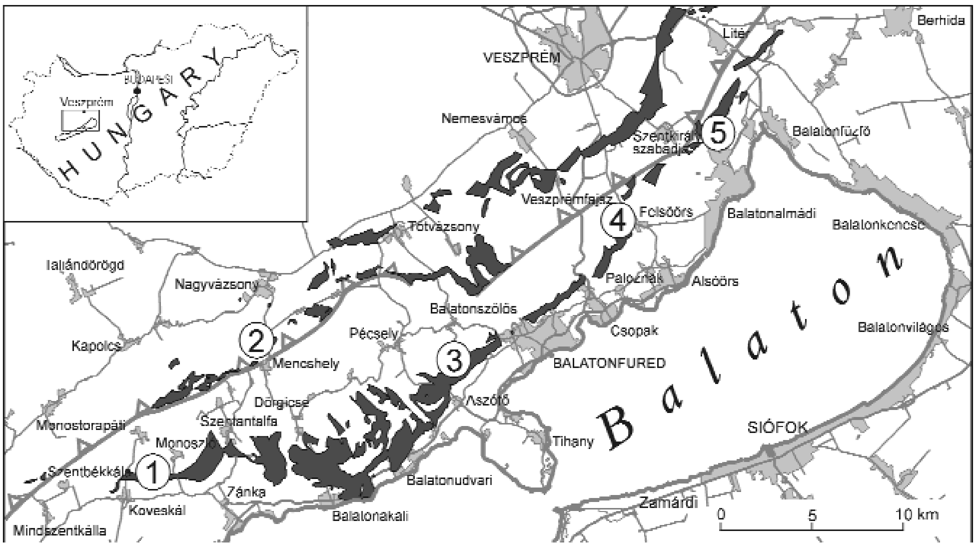

Figure Br-1. The studied Pelsonian brachiopod localities of the Balaton Highland. The distribution of Pelsonian formations is shown dark shaded (barbed line marks the Litér overthrust)
1 — Köveskál, Horog-hegy; 2 — Mencshely, Cser-tető, Section III; 3 — Aszófő, Farkó-kő; 4 — Felsőörs, Forrás-hegy; 5 — Vörösberény, road cut

Interest in the stratigraphy of the Pelsonian Substage at its type area on the Balaton Highland has renewed in recent years. A collaborative research project led by A. Vörös provided an opportunity to complete publication of brachiopod faunal data gathered over the past nearly 20 years. Within this volume dedicated to the Pelsonian and its fauna, it is fitting to briefly summarize the available information on brachiopods. Besides, the main aim of this contribution is to provide a systematic description of the athyridid, spiriferid and terebratulid taxa, to complement the previously published treatment of rhynchonellids (PÁLFY 1988).

The author is indebted to A. Vörös for his continuous encouragement and advice from the early stages of this study as a thesis project to the eventual manuscript production many years later. A. Galácz supervised the original thesis research at the Eötvös University. The manuscript was critically read by J. Haas and A. Vörös. Photography was done by Á. Marosfalvi. The author was supported by a Bolyai Research Fellowship. The research was supported by Hungarian Scientific Research Fund grants T026278 and T043325.

LOCALITIES

The faunas described herein were collected from measured stratigraphic sections at five localities, listed from west to east: Köveskál (Horog-hegy), Mencshely (Cser-tető III), Aszófő II, Felsőörs (Forrás-hegy), and Vörösberény (road cut) (Figure Br-1). Detailed stratigraphic logs of the measured sections are provided elsewhere in this volume (Figures S-3, S-5, and S-9 in VÖRÖS *et al.*, this volume).

THE FAUNA

Brachiopods occur in great abundance at certain levels of the Felsőörs Formation (Figure Br-2). In the course of this study 34 species were distinguished. *Thecocyrtella horogensis* is described herein as new. The occurrence of the identified taxa at the studied localities is summarized in Table Br-1. Detailed information on their stratigraphic distribution (collection levels) and abundance (specimen numbers) in the three main localities (Köveskál, Aszófő and Felsőörs) is listed in the Appendix Br-1.

SYSTEMATIC PALAEONTOLOGY (EXCLUDING RHYNCHONELLIDA)

The most recent classification of the phylum Brachiopoda was developed during the preparation of the revised edition of relevant volumes of Treatise on Invertebrate Palaeontology. Herein we follow the supraordinal classification of brachiopods as outlined by WILLIAMS *et al.* (1996). The classification of athyridids is adopted from ALVAREZ *et al.*

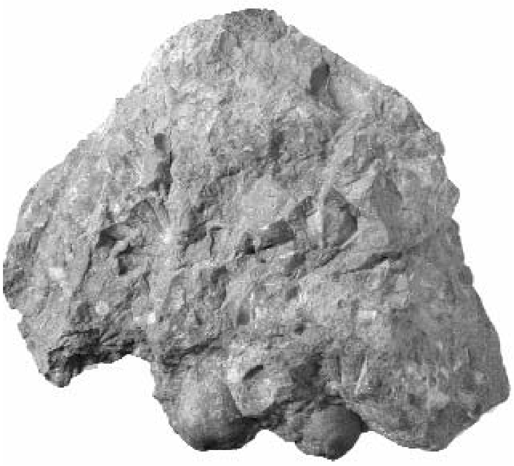

Figure Br-2. Fossiliferous slab of Pelsonian crinoidal-brachiopodal limestone from the "upper Recoaro bed" of Horog-hegy at Köveskál, with several specimens of *Mentzelia mentzeli* and *Tetractinella trigonella*. Width of slab is 15.5 cm (Hungarian Natural History Museum inventory number M.92.391)

Table Br-1. Summary of occurrences of Pelsonian brachiopod taxa at the studied localities of the Balaton Highland

	Localities:				
Taxa	Köveskál	Aszófő	Felsőörs	Mencshely	Vörösberény
Discinisca sp.	+				
Lingula cf. *tenuissima* BRONN, 1837	+				
Norella ? sp.	+			+	
Costirhynchopsis mentzeli (BUCH, 1843)	+	+			
Decurtella decurtata (GIRARD, 1843)	+	+	+		+
Decurtella cf. *illyrica* (BITTNER, 1903)		+			
Piarorhynchella trinodosi (BITTNER, 1890)	+	+	+	+	
Volirhynchia vivida (BITTNER, 1890)	+		+		+
Volirhynchia projectifrons (BITTNER, 1890)		+	+		
Volirhynchia productifrons (BITTNER, 1890)		+			
Volirhynchia tommasi (BITTNER, 1890)	+	+			
Caucasorhynchia cf. *altaplecta* (BÖCKH, 1872)	+		+		
Trigonirhynchella attilina (BITTNER, 1890)		+	+		
Homoeorhynchia ? sp.		+			
Holcorhynchella delicatula (BITTNER, 1890)		+		+	
Tetractinella trigonella (SCHLOTHEIM, 1820)	+	+	+		
Schwagerispira cf. *mojsisovicsi* (BÖCKH, 1872)	+	+	+		
Schwagerispira schwageri (BITTNER, 1890)	+	+	+		+
Costispiriferina manca (BITTNER, 1890)	+				
Dinarispira avarica (BITTNER, 1890)	+				
Dinarispira cf. *dinarica* (BITTNER, 1890)	+				
Sinucosta pectinata (BITTNER, 1890)	+				
Punctospirella fragilis (SCHLOTHEIM, 1814)	+	+			
Mentzelia mentzeli (DUNKER, 1851)	+	+	+	+	
Mentzelia balatonica (BITTNER, 1890)			+		
Koeveskallina koeveskalyensis (STUR, 1865)	+	+	+		
Koeveskallina paleotypus (LORETZ, 1875)		+			
Thecocyrtella horogensis n. sp.	+				
Coenothyris vulgaris (SCHLOTHEIM, 1820)	+	+	+		
Coenothyris cf. *cuccensis* BITTNER, 1890		+			
Coenothyris cf. *kraffti* BITTNER, 1890		+			
Coenothyris ? aff. *kraffti* BITTNER, 1890		+			
Sulcatinella incrassata (BITTNER, 1890)		+			
Angustothyris ? *angustaeformis* (BÖCKH, 1872)	+	+	+		
Angustothyris ? sp.				+	

(1998), also developed for the Treatise volume (WILLIAMS *et al.* 2002). As the parts of the Treatise that cover spiriferids and terebratulids have not been published yet, the low-level (subordinal) classification of these groups follows the seminal monograph of DAGYS (1974).

The studied material is deposited in the collection of Geological and Palaeontological Department of the Hungarian Natural History Museum (Budapest). The inventory numbers of figured specimens are given in the plate explanation.

The measurements are given in millimetres, conventional abbreviations are used as follows: L = length, W = width, T = thickness.

Internal characters are described where the available material (preservation and number of specimens) permitted the use of serial sectioning.

Phylum Brachiopoda DUMÉRIL, 1806
Subphylum Rhynchonelliformea WILLIAMS *et al.,* 1996
Class Rhynchonellata WILLIAMS *et al.,* 1996
Order Athyridida BOUCOT, JOHNSON & STATON, 1964
Suborder Athyrididina BOUCOT, JOHNSON & STATON, 1964
Superfamily Athyridoidea DAVIDSON, 1881
Family Diplospirellidae SCHUCHERT, 1894
Subfamily Tetractinellinae GRUNT, 1986

Genus **Tetractinella** BITTNER, 1890

Tetractinella trigonella **(SCHLOTHEIM, 1820)**

(Plate Br-I, 1)

1871 *Terebratula* (*Spirigera*) *trigonelloides* SCHLOTH. — QUENSTEDT, p. 255, pl. 45, figs. 13–21.
1890 *Spirigera trigonella* SCHLOTH. — BITTNER, p. 17, pl. 36, figs. 8–31.
1902 *Spirigera* (*Tetractinella*) *trigonella* SCHLOTH. — BITTNER, p. 507, 532, 567, pl. 23, figs. 23–26.
1906 *Spirigera trigonella* SCHLOTH. — ARTHABER, pl. 35, fig. 7.
1937 *Spirigera* (*Tetractinella*) *trigonella* V. SCHLOTH. — ASSMANN, p. 31, pl. 6, fig. 12.
1949 *Spirigera trigonella* SCHLOTH. — BESIĆ, p. 114, pl. 1, figs. 16–20.
1967 *Tetractinella trigonella* (SCHLOTHEIM) — SPECIALE, p. 1087, pl. 79, fig. 4.
1967 *Tetractinella trigonella* (SCHLOTHEIM) — CASATI & GNACCOLINI, p. 123, pl. 9, fig. 10.
1972 *Tetractinella trigonella* (SCHLOTHEIM) — SIBLÍK, p. 189, pl. 61, figs. 1, 6–8. text-figs. 4–15.
1972 *Tetractinella trigonella* (SCHLOTHEIM) — SCHOLZ, pl. 8, fig. 1.
1974 *Tetractinella trigonella* (SCHLOTHEIM) — DAGYS, pl. 45, fig. 3.
1988 *Tetractinella trigonella* (SCHLOTHEIM, 1820) — SIBLÍK, p. 85.
1990 *Tetractinella trigonella* (SCHLOTHEIM, 1820) — USNARSKA–TALERZAK, p. 686, pl. 2, fig. 1, fig. 7.
1991 *Tetractinella trigonella* (SCHLOTHEIM, 1820) — SIBLÍK, p. 168, pl. 1, fig. 6.
1992 *Tetractinella trigonella* (SCHLOTHEIM, 1820) — UROŠEVIĆ, RADULOVIĆ & PESIĆ, p. 475, pl. 1, fig. 8.
1993 *Tetractinella trigonella* (SCHLOTHEIM) — IORDAN, pl. 1, fig. 4.
1993 *Tetractinella trigonella* (SCHLOTHEIM) — TÖRÖK, p. 165, pl. 2, fig. 7.
1993 *Tetractinella trigonella* VON SCHLOTHEIM, 1820 — ANGIOLINI, p. 287, pl. 1, figs. 3–4.
1997 *Tetractinella trigonella* (SCHLOTHEIM, 1820) — KAIM, fig. 17.
1997 *Tetractinella trigonella* (SCHLOTHEIM, 1820) — TORTI & ANGIOLINI, p. 158, pl. 1, fig. 14.
1999 *Tetractinella trigonella* (SCHLOTHEIM, 1820) — SULSER, p. 116, 1 fig.
2001 *Tetractinella trigonella* (SCHLOTHEIM, 1820) — SIBLÍK, p. 26.
2002 *Tetractinella trigonella* (SCHLOTHEIM 1820) — MANTOVANI, p. 38, text-figs. 1–12, pl. 1, figs. 1–6, 9–12, pl. 2, figs. 1–6.

Material: This species occurs at all the three major localities studied. Sixty mostly shelly and articulated specimens were collected from Aszófő. At Köveskál, the "upper Recoaro bed" yielded 139 specimens, mostly disarticulated valves and only 10 articulated shells. On the contrary, most of the 262 specimens recovered from the "lower Recoaro bed" are well-preserved, articulated shells. From Felsőörs, 142 of a total of 148 specimens are articulated, albeit commonly secondarily deformed shells.

Dimensions: The length, width, and thickness measurements of 23 specimens from the "upper Recoaro" and 15 specimens from the "lower Recoaro" at Köveskál, 10 specimens from Felsőörs, and 12 specimens from Aszófő are plotted on Figures Br-3 and Br-4.

Description: Medium sized, pentagonal in outline. Greatest width attained at anterior third, where lateral costae reach the antero-lateral margin. Greatest thickness attained at half length. Apical angle highly variable between 45° and 85°. Beak small, suberect. Pedicular foramen epithyridid. Ornamentation dominated by four prominent costae that run from umbo to anterior margin. Costae form opposing pairs on ventral and dorsal valve; mostly straight, or slightly laterally curved; their profile narrow, acute, highly raised from surface of valves. Angles between ribs equal, or angle of central

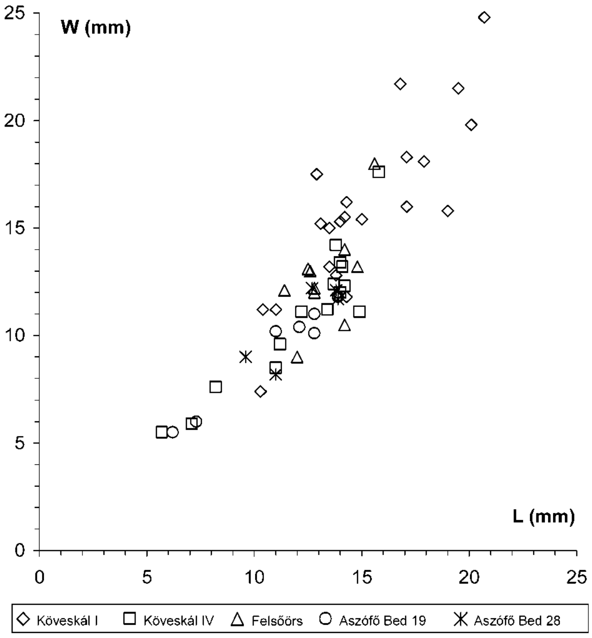

Figure Br-3. Cross plot of length vs. width of 60 measured specimens of *Tetractinella trigonella* from Köveskál (I — "upper Recoaro" IV — "lower Recoaro"), Felsőörs, and Aszófő

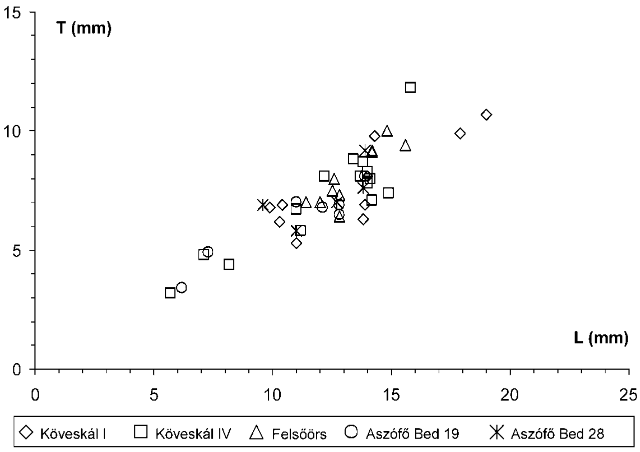

Figure Br-4. Cross plot of length vs. thickness of 60 measured specimens of *Tetractinella trigonella* from Köveskál (I — "upper Recoaro", IV — "lower Recoaro"), Felsőörs, and Aszófő

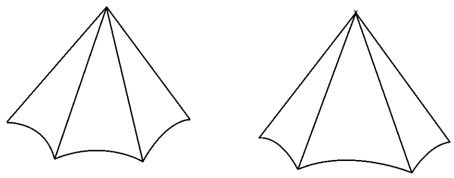

Figure Br-5. Two common morphotypes of *Tetractinella trigonella,* one with even sector angles, the other with larger angle between the middle two ribs

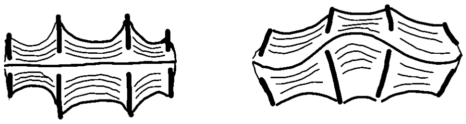

Figure Br-6. Anterior view of two common morphotypes of *Tetractinella trigonella,* one with straight margin, the other with gently uniplicate margin

sector larger than that of two lateral sectors (Figure Br-5). Few specimens from Aszófő possess a smaller secondary costa developed beside one of the inner ribs. Interspaces wide and flat. Anterior margin most commonly rectimarginate (metacarinate), rarely slightly uniplicate (Figure Br-6). Planareas well-developed around lateral margins, bound by lateral valve edges. Planarea flat or slightly convex, divided into two equal halves by lateral commissure. Additional ornamentation consists of fine growth lines, most characteristically on specimens from Felsőörs.

Variability: Characteristic features leave little doubt about conspecificity of all specimens, despite significant intraspecific variability. Convexity (thickness to length ratio) and length to width ratio are relatively constant, as also documented recently by MANTOVANI (2002). The apical angle, angles between ribs, and anterior commissure, however, display significant variability (Figures Br-5 and Br-6). Development of a fifth, secondary rib is also noted on some specimens. This is a rare phenomenon, nevertheless it is also reported by SIBLÍK (1972). Within the diagnostic pentagonal outline the ratio of side lengths and their angles also show some variability.

Remarks: The variability of the studied material support the conclusions of DETRE (1971) and SIBLÍK (1972). However, the bicostate form described by the latter author is considered here to belong to *Tetractinella cornutula*.

Superfamily Retzioidea WAAGEN, 1883
Family Neoretziidae DAGYS, 1972
Subfamily Hustediinae GRUNT, 1986

Genus **Schwagerispira** DAGYS, 1972
***Schwagerispira mojsisovicsi* (BÖCKH, 1872)**
(Pl. Br-1, 4)

1872 *Retzia Mojsisovicsi* n. sp. — BÖCKH, p. 165, pl. 11, fig. 30.
1890 *Retzia Mojsisovicsi* BOECKH — BITTNER, p. 20.
1890 *Retzia speciosa* n. sp. — BITTNER, p. 43, pl. 33, figs. 14–15.

1892 *Retzia speciosa* BITTNER — BITTNER, p. 4, pl. 1, fig. 17.
1895 *Retzia mojsisovicsi* BOECKH — SALOMON, p. 96, pl. 3, figs. 8–12.
1912 *Retzia Mojsisovicsi* BÖCKH var. *speciosa* BITTNER — FRECH, p. 25, text-fig. 36.
1912 *Retzia Mojsisovicsi* BOECKH — DE TONI, p. 337.
1972 „*Retzia*" *mojsisovicsi* BOECKH — SIBLÍK, p. 185.
1988 *Schwagerispira mojsisovicsi* (BÖCKH, 1872) — SIBLÍK, p. 90.

Material: Mostly well preserved, articulated specimens, 2 from Aszófő, 6 from Köveskál, and 16 from Felsőörs.
Dimensions: The table contains measurements (in mm) of six specimens and the holotype.

	Felsőörs					Köveskál	Holotype
L	8.9	8.6	8.8	8.1	9.1	9.2	8
W	6.9	6.8	7.2	6.6	7.2	7.7	7
T	5.8	5.5	3.2	5.1	5.5	5.9	5

Description: Small or medium sized, elongate form of pentagonal outline. Biconvex, valves of equal convexity. Greatest width and thickness attained at mid-length. Beak suberect, pointed, relatively high. Interarea small, bound by edges. Lateral and anterior margins straight, commissure zigzagged. Surface of valves densely and evenly costate. Costae straight, simple with no bifurcation, of rounded, semicircular profile. Interspaces narrower than rib bases. Number of costae 13 to 15 on each valve. Median area flat, occupied by four or five costae.

Remarks: Felsőörs is the type locality of the species. The thorough description of BÖCKH (1872) leaves little doubt that the newly obtained material is safely assigned to this species. BITTNER (1890) described *Retzia speciosa* from Schreyeralm, noting its close affinity to *"R." mojsisovicsi*. Later collections from the Southern Alps led VINASSA DE REGNY (1903) and DE TONI (1912) to interpret *"R." speciosa* as a junior synonym of *"R." mojsisovicsi*. *Schwagerispira mojsisovicsi* bears resemblance to *S. schwageri* (BITTNER, 1890). The latter species also occurs in the Balaton Highland (see Plate Br-I, 3). It is distinguished by its less dense costation (7 to 9 ribs) and more convex, spherical shell shape.

Schwagerispira schwageri (BITTNER, 1890)
(Plate Br-I, 3)

1890 *Retzia Schwageri* nov. spec. — BITTNER, p. 21, pl. 36, figs. 1–4.
1974 *Schwagerispira schwageri* — DAGYS, p. 168, text-fig. 113, pl. 42, fig. 8.

Material: Well preserved, articulated specimens, 2 from Aszófő, 1 from Köveskál, and 1 from Felsőörs.
Dimensions: The figured specimen has the following measurements (in mm): L = 7.1, W = 6.0, T = 5.2.
Description: Small form of subpentagonal outline. Biconvex, dorsal valve more convex than ventral one. Greatest width and thickness attained at mid-length. Beak suberect, pointed, relatively high. Lateral and anterior margins straight, commissure zigzagged. Surface of valves coarsely and evenly costate. Costae straight, simple with no bifurcation, of subtriangular profile. Interspaces narrower than rib bases. Number of costae 7 to 9 on each valve.

Remarks: Three of the four original specimens of Bittner was collected from Köveskál. *Schwagerispira schwageri* is similar to *S. mojsisovicsi* (BÖCKH, 1872), differing from the latter by its less dense costation and more convex, almost spherical shell shape.

Order Spiriferinida IVANOVA, 1972
Superfamily Spiriferinoidea DAVIDSON, 1884
Family Spiriferinidae DAVIDSON, 1884
Subfamily Spiriferininae DAVIDSON, 1884

Genus **Costispiriferina** DAGYS, 1974
Costispiriferina manca (BITTNER, 1890)
(Plate Br-I, 5–8)

1890 *Spiriferina manca* n. sp. — BITTNER, p. 30, pl. 35, figs. 12–16.
1912 *Spiriferina manca* BITTNER — DE TONI, p. 333, pl. 1, fig. 4.
1972 *Spiriferina manca* BITTNER — SCHOLZ, pl. 7, figs. 11–13.
1988 *Costispiriferina manca* (BITTNER, 1890) — SIBLÍK, p. 63.

Material: This species was collected only from Köveskál, where it occurs in abundance in the "upper Recoaro" bed. All of the 63 specimens are disarticulated valves. The majority is dorsal valves, only 8 of them are ventral valves.

Dimensions: Size variability is confined to a narrow range. Typical dimensions (in mm) are as follows: L = 6.0, W = 10.0, T (ventral valve) = 6.0, T (dorsal valve) = 2.0.

Description: Small sized shells, semicircular in outline. Valves highly unequal, dorsal valve only slightly, ventral one strongly convex. Beak small, ventral interarea high and catacline (normal to plane of commissure). Delthyrium narrow, approximately one fifth of total width. Dorsal umbo low. Maximum width and thickness reached at hinge line. Anterior margin semicircular, zigzagged, forming single, narrow, crescent-shaped plication. Both valves costate, albeit their ribbing pattern differs. Dorsal valve bears a wide median costa, opposite to an interspace bordered by pronounced costae on ventral valve. Number of lateral costae varies between 3 to 5, costae start from umbonal area, lack bifurcation, straight or gently arched laterally nearing anterior margin of dorsal valve. Rib cross section blunt triangular, except for dorsal median costa of semicircular profile.

Remarks: Köveskál is the type locality of the species. The specimen figured by DE TONI (1912) is a more densely costate ventral valve. The ribbing style of dorsal valves is similar to that of *Punctospirella fragilis*; distinguishing of these species is easier by a comparison of ventral valves.

Stratigraphic and geographic distribution: Apart from its type locality, the species is known from Pelsonian strata of the Southern Alps, Tirol, and the Aggtelek Mts.

Genus **Dinarispira** DAGYS, 1974

***Dinarispira avarica* (BITTNER, 1890)**

(Plate Br-I, 9–10)

1890 *Spiriferina avarica* nov. spec. — BITTNER, p. 35, pl. 35, figs. 6–7.
1902 *Spiriferina avarica* BITTNER — BITTNER, p. 513, 576, pl. 26, figs. 5–10.
1912 *Spiriferina avarica* BITTNER — DE TONI, p. 332.
1972 *Spiriferina avarica* BITTNER — SCHOLZ, pl. 7, figs. 7, 10.

Material: Two specimens from Bed 28 at Aszófő, 43 specimens from the upper, and 9 from the "lower Recoaro" bed of Köveskál. All are disarticulated valves, dorsal and ventral valves are equally represented.

Dimensions: Typical measurements (in mm) fall in the following ranges: L = 10–14, W = 13–18, T (ventral valve) = 5–8, T (dorsal valve) = 3–5.

Description: Oval or rounded shells of medium size. Anterior margin elliptical in outline. Maximum width attained immediately below hinge line, maximum thickness below umbo. Biconvex form, ventral valve markedly more convex than dorsal one. Beak straight, elongate, projecting above hinge. Ventral interarea apsacline, normal to plane of commissure at hinge then deflected towards the beak. Anterior commissure straight or slightly uniplicate, zigzagged. Valves costate, rib profile rounded. Two main costae flank a wide interspace which may be divided by two costellae. Lateral wings have additional two or three costae, slightly arched and diverging away from center of valve. Specimens from Köveskál commonly bear growth lines near anterior margin. Shell commonly thick, displaying well developed punctate structure.

Remarks: This species bears resemblance to several closely related spiriferids. It is distinguished from *Punctospirella fragilis* by its higher beak, from *Dinarispira pia* or *D. dinarica* (Plate I, 11–12) by its less dense costation.

Stratigraphic and geographic distribution: Apart from its type area, the species has been recorded from the Anisian of the Southern Alps and Dinarids.

***Dinarispira* cf. *dinarica* (BITTNER, 1890)**

(Plate Br-I, 11–12)

1890 *Spiriferina pia* nov. spec. var. *dinarica* nov. — BITTNER, p. 35, pl. 35, fig. 23.
1997 *Dinarispira* cf. *dinarica* (BITTNER, 1890) — TORTI & ANGIOLINI, p. 163, pl. 1, figs. 23–24; pl. 2, fig. 4.

Material: Seven specimens, all single valves, were collected from Köveskál.

Dimensions: Measurements of the two figured specimens are as follows (in mm): L = 9.0, 12.0; W = 13.0, 19.0.

Description: Shells of medium size and semicircular outline. Maximum width attained immediately below hinge line, maximum thickness below umbo. Anterior commissure straight, zigzagged. Valves costate, rib profile rounded. Number of costae between 8 and 10. Two main costae flank a median interspace which is only slightly wider than the others.

Remarks: This species is distinguished from the closely related species *D. avarica* by its somewhat more dense costation.

Genus **Sinucosta** Dagys, 1963
Sinucosta pectinata **(Bittner, 1890)**

1890 *Spiriferina pectinata* nov. spec. — Bittner, p. 31, pl. 35, figs. 24–25.

Material: Seven specimens, all single valves and more or less fragmentary, from Köveskál.

Remarks: In the lack of complete, well preserved specimens, no complete description can be given. Our largest specimen is >15 mm in width and <10 mm in length, characterized by a wide hinge line and semicircular anterior margin. This is the most densely costate form among the studied spiriferids, bearing more than 20 costae on its dorsal valve. A relatively narrow and low median sulcus does not interrupt the costation pattern, bearing 3–4 costae. The dense ribbing distinguishes this form from otherwise similar species, *e.g. Punctospirella fragilis*. Another closely resembling species is *Hirsutella hirsuta*, which tends to have a greater W/L ratio, somewhat more pronounced median fold, and a much thicker ventral valve.

Subfamily Punctospirellinae Davidson, 1884

Genus **Punctospirella** Dagys, 1974
Punctospirella fragilis **(Schlotheim, 1814)**
(Plate Br-I, 13–14)

1871 *Spiriferina fragilis* Schloth. — Quenstedt, p. 500, pl. 53, figs. 39–41.
1890 *Spiriferina fragilis* Schloth. — Bittner, p. 29, pl. 35, figs. 2–4.
1895 *Spiriferina fragilis* v. Schloth. — Salomon, p. 82, 140, pl. 2, figs. 18–19.
1906 *Spiriferina fragilis* Schloth. — Arthaber, pl. 35, fig. 9.
1914 *Spiriferina fragilis* Schloth. — Arthaber, p. 193, pl. 18, fig. 9.
1937 *Spiriferina fragilis* v. Schloth. — Assmann, p. 29, pl. 6, fig. 7.
1967 *Spiriferina fragilis* (Schlotheim) — Speciale, p. 1088, pl. 79, fig. 5.
1967 *Spiriferina fragilis* (Schlotheim) — Casati & Gnaccolini, p. 124, 138, pl. 11, figs. 9–10.
1972 *Spiriferina fragilis* Schlotheim — Siblík, p. 181, pl. 61, fig. 2.
1974 *Punctospirella fragilis* (Schlotheim) — Dagys, pl. 39, figs. 2–3.
1988 *Punctospirella fragilis* (Schlotheim, 1813) — Siblík, p. 67.
1990 *Punctospirella fragilis* (Schlotheim, 1814) — Usnarska-Talerzak, p. 688, pl. 2, fig. 2.
1992 *Punctospirella fragilis* (Schlotheim, 1814) — Urošević, Radulović & Pesić, p. 473, pl. 1, figs. 4–6.
1993 *Punctospirella fragilis* (Schlotheim) — Urlichs, p. 211, figs. 2a–e.
1993 *Punctospirella fragilis* (Schlotheim) — Iordan, pl. 1, fig. 9.
1993 *Punctospirella fragilis* (Schlotheim) — Török, p. 165, pl. 2, fig. 4.
1997 *Punctospirella fragilis* (Schlotheim, 1814) — Kaim, fig. 19b.
1999 *Punctospirella fragilis* (Schlotheim, 1813) — Sulser, p. 128, 1 fig.
2001 *Punctospirella fragilis* (Schlotheim, 1813) — Siblík, p. 21.

Material: The Aszófő section yielded 29 specimens, another 15 specimens were collected at Köveskál. All are disarticulated valves, mostly fragmentary, only a few complete and well-preserved specimens are available.

Dimensions: Average measurements are as follows (in mm): L = 10, W = 15, T (dorsal valve) = 4, T (ventral valve) = 5.

Description: Shells of medium size. Hinge line broad, anterior margin with elliptical outline. Greatest width attained at hinge line, greatest thickness below umbo. Biconvex, both valves equally and moderately convex. Beak slightly erect, of medium size. Interarea wide and low. Delthyrium cannot be studied on available specimens. Umbo of dorsal valve small. Anterior margin straight but zigzagged. Valves entirely costate; ribs strong, straight, divergent anteriorly. Costae and interspaces evenly distributed, of rounded cross section. Ribbing style of two valves slightly different, ventral valve dominated by median interspace and two flanking main ribs. Main median rib of opposing dorsal valve broader than 4–5 lateral ribs.

Remarks: This is historically the first described Middle Triassic brachiopod species, therefore it is abundantly recorded in the literature. The median rib and corresponding interspace appears less prominent in Muschelkalk faunas of the Germanic Basin. This feature shows the largest variability, *e.g.* specimens figured by Salomon (1895) display stronger median rib than the Balaton material, which is best comparable with that described by Speciale (1967).

Stratigraphic and geographic distribution: This species is known from both the Alpine and Germanic areas, from Anisian and Ladinian strata of Germany, Silesia, the Southern Alps, Dinarides, and Western Carpathians.

Subfamily Mentzeliinae DAVIDSON, 1884

Genus **Mentzelia** QUENSTEDT, 1871

***Mentzelia mentzeli* (DUNKER, 1851)**

(Plate Br-I, 15)

1890 *Spiriferina* (*Mentzelia*) *Mentzelii* DUNKER — BITTNER, p. 22, pl. 34, figs. 1–19.
1906 *Spiriferina* (*Mentzelia*) *Mentzelii* DUNK. — ARTHABER, pl. 35, fig. 13.
1912 *Spiriferina Mentzeli* DUNK. — DE TONI, p. 328, pl. 1, fig. 5.
1937 *Spiriferina* (*Mentzelia*) *mentzelii* DUNKER — ASSMANN, p. 30, pl. 6, figs. 10–11.
1967 *Mentzelia mentzelii* (DUNKER) — CASATI & GNACCOLINI, p. 124, pl. 9, figs. 4, 9.
1969 *Mentzelia mentzeli mentzeli* (DUNKER) — GAETANI, p. 507, pl. 34, figs. 8–10, text-fig. 8.
1972 *Mentzelia mentzeli mentzeli* (DUNKER) — SIBLÍK, p. 183, pl. 42, fig. 1.
1974 *Mentzelia mentzeli* (DUNKER) — DAGYS, pl. 40, fig. 1.
1988 *Mentzelia mentzeli* (DUNKER, 1851) — SIBLÍK, p. 66.
1992 *Mentzelia mentzeli* (DUNKER, 1851) — UROŠEVIĆ, RADULOVIĆ & PESIĆ, p. 475, pl. 1, fig. 7.
1993 *Mentzelia mentzeli* (DUNKER, 1851) — ANGIOLINI, p. 295, pl. 6, figs. 6–8.
1993 *Mentzelia mentzeli* (DUNKER) — IORDAN, pl. 1, fig. 14.
1997 *Mentzelia mentzeli* (DUNKER, 1851) — TORTI & ANGIOLINI, p. 161, pl. 1, figs. 20–21, pl. 3, figs. 17–19.
1999 *Mentzelia mentzeli* (DUNKER 1851) — SULSER, p. 127, 1 fig.
2001 *Mentzelia mentzeli* (DUNKER, 1851) — SIBLÍK, p. 20.

Material: Abundant collections were made at Aszófő (402 specimens) and Köveskál (266), with additional material from Felsőörs (5). All are disarticulated valves, except for two articulated specimens from Aszófő. At Köveskál ventral valves are more common than dorsal valves in the "upper Recoaro" bed, whereas their number is approximately equal at Aszófő.

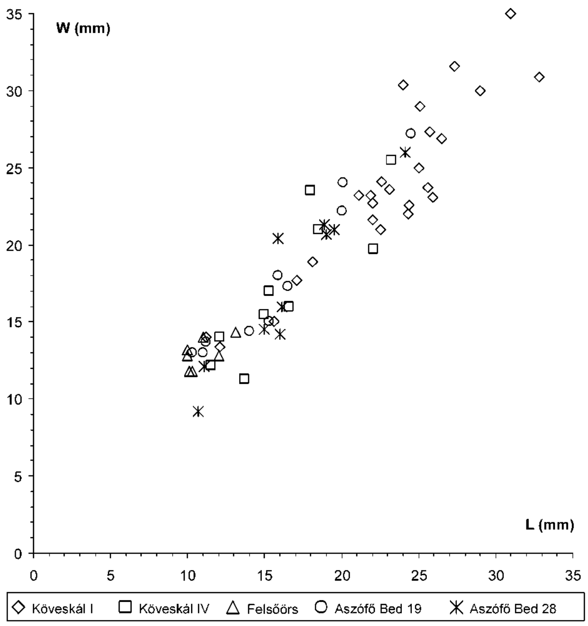

Figure Br-7. Cross plot of length vs. width of 65 measured specimens of *Mentzelia mentzeli* from Köveskál (I — "upper Recoaro", IV — "lower Recoaro"), Felsőörs, and Aszófő

Dimensions: Figure Br-7 shows measurements made on 65 specimens.

Description: Round or oval shells of medium to large size. Biconvex, ventral valve is more convex than dorsal one. Largest width attained at posterior third, largest thickness at half length. Anterior margin semicircular. Width of hinge line variable, usually approximately half of total width. Beak medium-sized, curved. Interarea of moderate height, apsacline. Delthyrium open, occupying medium third of interarea. Ventral interarea bordered by beak ridges. Anterior commissure straight, some adult specimens display uniplication, with low and gently arched fold. Shell surface most commonly smooth, or capillate on some specimens. Well developed growth folds near the anterior margin occur commonly on specimens from Köveskál.

Remarks: Mentzelia mentzeli is a long-established and widely distributed species. BITTNER (1890) distinguished numerous subspecies within it (*acrorhyncha, baconica, brevirostris, illyrica, judicarica, media*). He also described two new, closely allied species as *Spiriferina balatonica* and *S. pannonica*. Although the infraspecific systematics of *M. mentzeli* is in need of revision, the Balaton Highland specimens agree well with the nominate subspecies.

Two related species, *M. ampla* and *"Spiriferina ptychitiphila"* are distinguished by their blunt, straight and diverging edges flanking the sulcus on the ventral valve. *M. balatonica* (Plate Br-I, 16), whose type locality is Felsőörs, is distinguished by its prominent, narrow uniplication of semicircular profile, and its fine ribbing developed near the lateral and anterior margins.

Stratigraphic and geographic distribution: The species is widely distributed and common in both the Germanic and the western Tethyan basins. It reaches peak abundance in the Anisian but also ranges into the Ladinian.

***Mentzelia balatonica* (BITTNER, 1890)**

(Plate Br-I, 16)

1890 *Spiriferina balatonica* nov. spec. — BITTNER, p. 28, pl. 35, fig. 1.

Material: Two well preserved, articulated specimens from Felsőörs.

Dimensions: Measurements of the figured specimen are as follows (in mm): L = 11.8, W = 14.6, T = 10.1.

Description: Shell of medium size, outline subhexagonal, width slightly exceeding length. Biconvex, ventral valve slightly more convex than dorsal one. Largest width and thickness attained at posterior third. Width of hinge line approximately 3/4 of total width. Beak medium-sized, curved. Interarea of moderate height, apsacline. Delthyrium open, occupying a quarter of interarea. Anterior commissure bears well-developed uniplication. Fold narrow, nearly semicircular. Shell surface mostly smooth, except broad and low incipient costae developing towards anterior margin.

Remarks: Felsőörs is the type locality of this species. *M. balatonica* is distinguished from the much more common *M. mentzeli* by its angular, subhexagonal outline and distinctive, semicircular fold.

Stratigraphic and geographic distribution: So far this species is only known from its type locality, the Pelsonian of Felsőörs.

Genus **Koeveskallina** Dagys, 1965
***Koeveskallina koeveskalyensis* (Stur, 1865)**
(Plate Br-I, 17–21)

1856 *Spiriferina* n. sp. — Suess in Zepharovich, p. 369.
1865 *Spiriferina Köveskalyensis* Suess — Stur, p. 245.
1872 *Spiriferina Köveskálliensis* Suess — Böckh, p. 162, pl. 11, figs. 22–23.
1890 *Spiriferina* (*Mentzelia*) *Köveskalliensis* (Suess) Böckh — Bittner, p. 26, pl. 34, figs. 29–34.
1890 *Spiriferina Köveskalliensis* Suess var. — Bittner, p. 44, pl. 33, fig. 16.
1895 *Spiriferina* cfr. *Spitiensis* Stoliczka — Salomon, p. 87, pl. 2, figs. 7–15.
1899 *Spiriferina Spitiensis* Stoliczka — Bittner, p. 21, pl. 4, figs. 15–16.
1902 *Spiriferina* (*Mentzelia*) *Köveskallinesis* Boeckh var. *validirostris* nov. — Bittner, p. 583, pl. 25, figs. 23–25.
1906 *Spiriferina* (*Mentzelia*) *Köveskalliensis* Suess — Arthaber, pl. 35, fig 11.
1967 *Koeveskallina koeveskalliensis* (Suess) — Casati & Gnaccolini, p. 125, pl. 9, fig. 7.
1972 *Koeveskallina koeveskalyensis* (Stur) — Siblík, p. 184, pl. 61, fig. 4, pl. 63, fig. 2.
1974 *Koeveskallina koeveskalliensis* Boeckh — Dagys, pl. 40, figs. 3–4.
1988 *Koeveskallina koeveskalyensis* (Stur, 1865) — Siblík, p. 64.
1993 *Koeveskallina koeveskalyensis* (Stur) — Iordan, pl. 1, figs. 7–8.
2001 *Koeveskallina koeveskalyensis* (Stur, 1865) — Siblík, p. 19.

Material: Thirty-five internal moulds with shell remains from Köveskál, 14 shelly specimens from Felsőörs, 19 from Aszófő. All are disarticulated valves, ventral and dorsal valves nearly equal in numbers.

Dimensions: The measurements (in mm) of representative specimens of ventral and dorsal valves (5 of each) are tabulated below.

Dorsal valves	Aszófő	Aszófő	Felsőörs	Köveskál	Köveskál
L	15.0	11.9	9.8	14.2	14.5
W	17.2	14.9	10.2	15.6	18.4
T	4.1	2.8	3.1	6.7	5.2

Ventral valves	Felsőörs	Felsőörs	Aszófő	Köveskál	Köveskál
L	10.1	10.1	10.4	17.5	13.3
W	8.5	8.9	12.1	16.9	14.1
T	6.8	6.9	5.8	9.4	7.1

Description: Medium sized, oval or subcircular in outline. Valves unequal, ventral valve more strongly convex than dorsal valve. Both valves attain greatest width at mid-length, greatest thickness measured at posterior third. Beak large and erect. Well-developed interarea of equilateral triangular shape. Width of hinge line is 2/3 of total width. Delthyrium wide; deltidial plates and foramen cannot be observed on available specimens. Lateral and anterior margin straight. Surface of both valves ornamented by dense ribbing. Rib profile rounded and blunt, ribs extend from umbo to anterior margin, without bifurcation. Concentric growth lines, perpendicular to ribs, characterize specimens from Felsőörs. Coarse rugae common on specimens from Aszófő.

Remarks: The type locality of the species is Köveskál. It is of historic interest that the first record dates back to 1856, when Suess mentioned the species in a single sentence (in Zepharovich 1856). Stur (1865) established the name of the species, as it was clarified by Siblík (1970) who discussed the authorship and nomenclature of the species. The first illustration was provided by Böckh (1872). Subsequent works introduced some confusion as Suess, Stur and Böckh were variably referred to as authors of the taxon, a controversy that was cleared by Siblík (1970). A Himalayan species, *Spirifer spitiensis* Stoliczka, 1865 is regarded synonymous with *K. koeveskalyensis*, following Diener (1920).

Stratigraphic and geographic distribution: The species has been recorded from Pelsonian and Illyrian strata of the Northern Calcareous Alps, Southern Alps, Western Carpathians, Dinarids, and the Himalayas.

Koeveskallina paleotypus (LORETZ, 1875)
(Plate Br-I, 22)

1875 *Spiriferina paleotypus* n. sp. — LORETZ, p. 802, pl. 21, fig. 1.
1890 *Spiriferina paleotypus* LORETZ — BITTNER, p. 28, pl. 35, figs. 9–11.
1912 *Spiriferina paleotypus* LOR. — DE TONI, p. 329, pl. 1, fig. 7.
?1967 *Koeveskallina* cf. *paleotypus* (LORETZ) — CASATI & GNACCOLINI, p. 127, pl. 9, fig. 2.
1988 *Koeveskallina paleotypus* (LORETZ, 1875) — SIBLÍK, p. 64.
2001 *Koeveskallina paleotypus* (LORETZ, 1875) —SIBLÍK, p. 19.

Material: 26 well preserved but disarticulated valves from Aszófő.

Dimensions: The length of entire valves ranges from 17 to 25 mm, width ranges from 21 to 30 mm.

Description: Large sized shell, rhomboidal in outline with semicircular anterior margin and high umbo. Biconvex, ventral valve more convex than dorsal one. Greatest width attained anteriorly from hinge, greatest thickness below umbo. Beak large, curved, projected high above hinge. Interarea wide but not high, bounded by edges. Umbo of dorsal valve stout. Anterior margin uniplicate, width of fold is ¼ of total width. Fold gently arched, forming no angles on the anterior margin, best developed on adult specimens. Surface of both valves evenly and densely costate. Costae fine, of rounded profile, their width slightly exceeds that of interspaces. Strength of costae increases from umbo towards anterior margin. Radial ornamentation consists of prominent, irregularly spaced rugae.

Remarks: Diagnostic features of the species include its dense costation and the uniplication. Together with its larger size, they distinguish *K. paleotypus* from *K. koeveskalyensis*. The species differs from similarly large specimens of *Mentzelia mentzeli* by its costation: *M. mentzeli* is typically smooth, only some subspecies develop costellation (*e.g. M. mentzeli judicarica*). The specimens from Aszófő agree well with the original description of the species, as well as the figured specimens of BITTNER (1890) and DE TONI (1912). The illustrated specimen of CASATI & GNACCOLINI (1967) appears smaller, its beak is lower, and the ribbing style is different. With no anterior view available, its identity is questionable.

Stratigraphic and geographic distribution: The species is known from several Anisian localities of the Southern Alps, Dinarids, and Caucasus.

Superfamily Suessioidea WAAGEN, 1883
Family Cyrtinidae FREDERIKS, 1912
Subfamily Thecocyrtellinae DAGYS, 1965

Genus **Thecocyrtella** BITTNER, 1892
Thecocyrtella horogensis new species
(Plate Br-I, 23, 34)

Diagnosis: Small, smooth cyrtinid shell of semicircular outline. Both valves symmetrical; dorsal valve nearly flat, ventral valve strongly convex, hemipyramidal; ventral interarea triangular, beak pointed.

Type material: Holotype M.92.492, a well-preserved, articulated specimen with shell remains, with the following dimensions (in mm): L = 6.8, W = 6.7, T = 5.3. Paratype M.2002.866, a well-preserved ventral valve with shell remains with the following dimensions (in mm): L = 5.8, W = 7.5, T = 5.6.

Type locality and stratigraphic horizon: Horog-hegy near Köveskál, Balaton Highland, Hungary; "lower Recoaro" bed of the Pelsonian Substage, Anisian Stage, Middle Triassic.

Etymology: Named after its type locality, Horog-hegy (= Horog Hill) near Köveskál.

Description: Small sized shell, semicircular in outline. Dorsal valve nearly flat, ventral valve strongly convex, hemipyramidal. Greatest width same as width of hinge line, greatest thickness same as height of interarea. Beak straight and pointed. Ventral interarea triangular in outline, height greater than its width. Delthyrium covered, symphytium observed on paratype. Umbo of dorsal valve small and pointed. Lateral and anterior margins straight. Shell surface smooth, except for faint growth lines developed on ventral valve. Some parts of shell remains appears to display punctate structure.

Remarks: Although only two specimens are available for study, their characteristic features cannot be identified with previously described forms and warrant the erection of a new species. The internal characters remain unknown as serial sectioning was precluded by the uniqueness of the articulated specimen. The peculiar "cyrtinid" shell shape allows the assignment to superfamily Suessioidea with confidence (following the classification adopted by WILLIAMS *et al.* 2002). The superfamily consists of two families, of which Suessiidae is distinguished on the basis of its internal characters and comprises a single genus of Jurassic age. Therefore our specimen is best accommodated in the family Cyrtinidae. Its generic composition and the distinction of genera is somewhat controversial. When erecting the family, BITTNER (1890) originally included two Triassic genera, *Cyrtotheca* and *Cyrtina*. Subsequently he also distinguished *Thecocyrtella* (Bittner 1892), later Hall & Clarke (1894) established *Bittnerula* and designated *Cyrtina zitteli* as its type species.

Dagys (1974) included *Cyrtotheca* and *Bittnerula* as synonyms within *Thecocyrtella* (sensu Bittner 1892) and designated *Cyrtotheca ampezzana* as type species. Undoubtedly this Carnian species shows the greatest resemblance to our form, in possessing symmetrical ventral valve (a feature not typical to most other Cyrtinidae), as well as in its small size and lack of ornamentation. It, however, differs from the new species by its greater length to width ratio. The only other cyrtinid brachiopod known from the Anisian is *Cyrtina katzeri* Bittner, 1902 (p. 600, pl. 26, fig. 4). Its asymmetric and ribbed shell suggests that it is not closely related to our form. In summary, the assignment of the herein described specimen to *Thecocyrtella* is justified using either the systematics of Dagys (1974) or Williams *et al.* (2002).

Order Terebratulida Waagen, 1883
Suborder Terebratulidina Waagen, 1883
Superfamily Dielasmatoidea Schuchert, 1913
Family Dielasmatidae Schuchert, 1913
Subfamily Dielasmatinae Schuchert, 1913

Genus **Coenothyris** Douvillé, 1879

***Coenothyris vulgaris* (Schlotheim, 1820)**

(Plate Br-I, 24–26)

1871 *Terebratula vulgaris* Schloth. — Quenstedt, p. 420, pl. 50, figs. 70–101.
1890 *Terebratula* (*Coenothyris*) *vulgaris* Schloth. — Bittner, p. 5, text-fig.
1899 *Terebratula* (*Coenothyris*) *vulgaris* Schloth. — Bittner, p. 28, pl. 5, fig. 14.
1906 *Terebratula* (*Coenothyris*) *vulgaris* Schloth. — Arthaber, pl. 35, figs. 4–6.
1937 *Coenothyris vulgaris* Schloth. — Assmann, p. 26, pl. 7, fig. 15.
1967 *Coenothyris vulgaris* (Schlotheim) — Speciale, p. 1089, pl. 79, figs. 6–8, pl. 80, figs. 1–7, text-figs. 9–14.
1971 *Coenothyris vulgaris* (Schlotheim) — Detre, p. 107, pl. 5, figs. 2–5, pl. 6. figs. 1–4, pl. 7, figs. 1–6, text-figs. 43–51.
1974 *Coenothyris vulgaris* Schlotheim — Dagys, pl. 46, fig. 2.
1988 *Coenothyris vulgaris* (Schlotheim, 1820) — Siblík, p. 92.
1988 *Coenothyris vulgaris* (Schlotheim) — Usnarska-Talerzak, p.173, figs. 2–26, 31.
1989 *Coenothyris vulgaris* (Schlotheim, 1820) — Popiel-Barczyk & Senkowiczowa, p. 98, pl. 1, 3–4, figs. 3–7.
1990 *Coenothyris vulgaris* (Schlotheim, 1820) — Usnarska-Talerzak, p. 680, pl. 1, fig. 1.
1992 *Coenothyris vulgaris* (Schlotheim 1820) — Urošević, Radulović & Pesić, p. 475, pl. 1, figs. 9–11, fig. 4.
1992 *Coenothyris vulgaris* (Schlotheim, 1820) — Detre in Detre, Lantos & Ó. Kovács, pl. 1–3, figs. 1–3.
1993 *Coenothyris vulgaris* (Schlotheim), 1820 — Senkowiczowa & Popiel-Barczyk, p. 582, pl. 1, fig. 3.
1993 *Coenothyris vulgaris* (Schlotheim) — Iordan, pl. 1, fig. 16.
1993 *Coenothyris vulgaris* (Schlotheim) — Török, pl. 2, figs. 3, 5, text-fig. 9.
1996 *Coenothyris vulgaris* (Schlotheim, 1820) — Senkowiczowa & Popiel-Barczyk, p. 457, pl. 1, fig. 7, figs. 7, 7a–c.
1996 *Coenothyris vulgaris* (von Schlotheim) — Trammer, Kaim & Malkowski, fig. 5.
1999 *Coenothyris vulgaris* (Schlotheim, 1820) — Sulser, p. 129, 1 fig.
2001 *Coenothyris vulgaris* (Schlotheim, 1820) — Siblík, p. 28.

Material: Abundant material is available from the three main localities: 22 specimens from Felsőörs, 34 from Köveskál, and 77 from Aszófő.

Description: Medium to large sized, circular or oval in outline. Isometric, greatest width and thickness attained at mid-length. Biconvex, both valves are moderately convex. Beak erect and stout, lacking beak ridges. Foramen permesothyridid. Lateral and anterior margins straight. Shell surface smooth, fine growth lines only occasionally developed.

Internal features (Figure Br-8): The less than ideal preservation of the serially sectioned specimens hindered the observation of all characters. Delthyrial cavity rounded. Pedicle collar well developed. Short, diverging dental plates developed close to the wall of ventral valve. Hinge plate narrow, septalium deep. A long median septum persists at least to mid-length. Loop

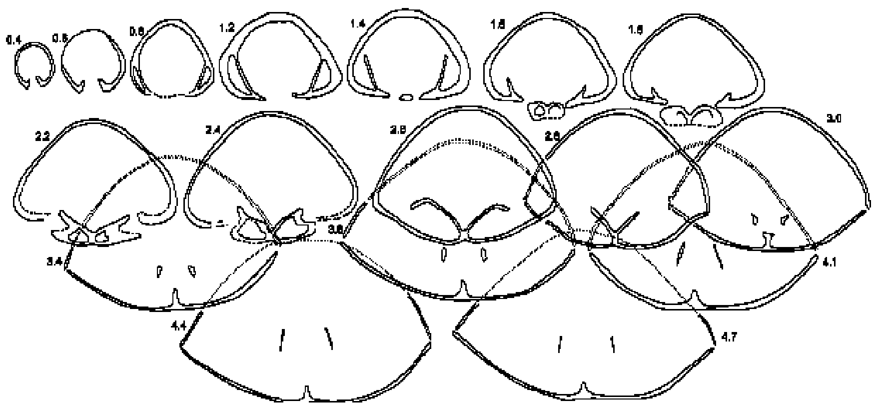

Figure Br-8. Transverse serial sections of a specimen of *Coenothyris vulgaris* from Aszófő. Distance from posterior end of shell given in mm. Length of specimen is 17.5 mm incomplete in observed specimens, ascending part not preserved. Descending branch long, narrow, subparallel, ribbon-like, nearly perpendicular to plane of commissure.

Remarks: The external morphology of the species is remarkably simple and poor in features. A morphometric characterization was attempted by DETRE (1971), DETRE *et al.* (1984). Until recently, no detailed description of the internal morphology was available. Among the few published sources for comparison of the internal characters were the serial sections and descriptions given by MUIR-WOOD (in MOORE 1965), DETRE (1971), DETRE *et al.* (1984), and DAGYS (1974). Specimens from the Mecsek Mts. were sectioned by Török and discussed in PÁLFY & TÖRÖK (1992). The possibility of polyspecific nature of *C. vulgaris* is suggested by the presence of divergent and short dental plates, deep septalium, long loop and median septum, which are in conflict with earlier observations. Concurrently with our study, USNARSKA-TALERZAK (1988) provided a detailed description of the internal morphology of *C. vulgaris*.

The external morphology is said to be variable. Previous descriptions included both rectimarginate and uniplicate forms. In Aszófő, these morphologies fall into two distinct populations that include adult specimens from within the same bed (*e.g.* Bed 19). Thus the uniplicate form is herein regarded as a separate species and identified as *C.* cf. *kraffti* (see Plate Br-I, 27–28), even though its internal features remain unknown. Another closely allied, but perhaps separate form is *C.* cf. *cuccensis* (Plate Br-I, 29), distinguished by its narrower and higher uniplication.

Stratigraphic and geographic distribution: C. vulgaris is one of the most common and abundant species in the Anisian of both the Germanic Basin and Tethyan localities.

***Coenothyris* cf. *cuccensis* BITTNER, 1902**
(Plate Br-I, 29)

1902 *Terebratula* (*Coenothyris*) *Cuccensis* nov. spec. — BITTNER, p. 528, pl. 18, fig. 33.

Material: A single specimen from Aszófő.

Dimensions (in mm): L = 18.0, W = 16.5, T = 9.5.

Remarks: This form is evidently closely allied with *Coenothyris vulgaris*, separated only on the basis of its narrow and high uniplication. Apart from this feature, other characteristics agree well with those of *C. vulgaris*. The identification remains somewhat doubtful as it is based on a single specimen and this species has not been reported in the literature except for its original description.

Stratigraphic and geographic distribution: Beside the Aszófő specimen, only the type material is illustrated from the Venetian Alps, although BITTNER (1902) also mentioned similar forms from the Sarajevo area.

***Coenothyris* cf. *kraffti* BITTNER, 1902**
(Plate Br-I, 27–28)

1902 *Terebratula* (*Coenothyris*) *Kraffti* nov. spec. — BITTNER, p. 527, pl. 18, figs. 30–32.

Material: 32 specimens from Aszófő.

Dimensions: Measurements of the two figured specimens (that represent typical adult individuals) are as follows (in mm): L = 25.4, 28.0; W = 21.8, 22.0; T = 15.2, 13.9.

Description: Large shell of suboval to subpentagonal outline. Greatest width and thickness attained at mid-length. Biconvex, ventral valve significantly more convex than dorsal one. Beak erect, no beak ridges present. Foramen permesothyridid. Anterior margin uniplicate, showing a tendency towards incipient biplication. Fold wide, taking up half of total width, its development starts only on anterior third of adult shell. Shell surface generally smooth, only in few cases bears extremely faint costellae and/or growth lines. Median septum and well developed adductor muscle scars observed through the dorsal valve of some specimens.

Remarks: This form is clearly separated from the rectimarginate population of *Coenothyris vulgaris* in several beds of the Aszófő section. Its diagnostic feature is the uniplication. It is best compared to *C. kraffti*, noting that the type of that species becomes more clearly biplicate at larger size.

Stratigraphic and geographic distribution: Beside the Aszófő specimens, only the type material is illustrated from the Venetian Alps.

***Coenothyris* ? aff. *kraffti* BITTNER, 1902**
(Plate Br-I, 2)

aff. 1902 *Terebratula* (*Coenothyris*) *Kraffti* nov. spec. — BITTNER, p. 527, pl. 18, figs. 30–32.

Material: 68 specimens from Aszófő and 2 from the "lower Recoaro" bed of Köveskál.

Dimensions: Measurements of the figured specimen (that represents a typical adult individual) are as follows (in mm): L = 20.2, W = 16.5, T = 11.9.

Description: Moderately large shell of subpentagonal outline. Ventral valve slightly more convex than dorsal one. Maximum width attained at 3/5 of length. Beak erect, foramen small. Anterior margin uniplicate, bearing a wide, perfectly flat fold with angular corners. Fold develops directly from dorsal umbo, demarcated by straight edges. Shell surface smooth.

Remarks: In earlier reports (Pálfy 1986, Vörös & Pálfy 2002) this species was referred to "*Pexidella*" aff. *sturi* (Böckh, 1872). Its punctate shell structure, however, clearly suggests that it is properly allocated to terebratulids, further supported by the lack of spiral brachidium in several specimens observed with broken umbo. Based on its external morphology, this form is close to *Coenothyris kraffti*. The main distinguishing feature is the early ontogenetic development of the uniplication and the presence of characteristic edges bordering the fold. This character is likely to justify its allocation to a separate species and perhaps even to a different genus, a question that remains to be solved using serial sectioning.

Genus **Sulcatinella** Dagys, 1974
Sulcatinella incrassata **(Bittner, 1890)**
(Plate Br-I, 30–31)

1890 *Waldheimia* (*Aulacothyris*) *angusta* v. Schloth. var. *incrassata* — Bittner, p. 8, pl. 41, figs. 23–26.

Material: Fifty-four, mostly well-preserved, articulated specimens from Aszófő and a single specimen from the "lower Recoaro" bed of Köveskál.

Dimensions: The measurements (in mm) of the two figured specimes are as follows. Plate Br-I, 30: L = 15.3, W = 13.5, T = 12.8; Plate Br-I, 31: L = 14.7, W = 11.5, T = 10.1.

Description: Small to medium sized, rounded pentagonal in outline. Ventral valve inflated, strongly convex, dorsal valve much less convex to nearly flat. Greatest width and thickness attained at mid-length. Beak straight, pointed, with straight beak ridges. Foramen mesothyridid. Posterior and lateral margins straight, thickened. Anterior margin sulcate, bearing a wide, nearly flat face and wide but shallow sulcus. Shell surface ornamented with fine, closely spaced growth lines.

Internal features (Figure Br-9): Ring-like pedicle collar surrounds inner margin of foramen. Dental plates long and parallel. Width of delthyrial cavity equals the combined width of umbonal cavities. Septalium deep, hinge plate at low position. Tooth sided by small denticle. Length of median septum reaches half of entire length, brachidium also at least of same length. Descending ribbon of loop first runs parallel to median septum, then turns parallel to plane of dorsal valve.

Remarks: The inflated shape and sulcate anterior margin agree well with the original description. The only difference is the straight beak of the Aszófő specimens as opposed to the erect beak of the holotype. The peculiar external morphology provides a basis to raise the rank of this taxon from variety (= subspecies), as proposed originally by Bittner (1890), to species. It is further supported by the investigation of internal morphology, which also allows a confident assignment to the genus *Sulcatinella*. Both the external and internal features of this species show good agreement with the diagnosis and description of Dagys (1974).

Externally the inflated shape, internally the presence of dental plates allow distinction from other sulcate terebratulids, such as *Angustothyris angustaeformis* and *Silesiathyris angusta*.

Stratigraphic and geographic distribution: Apart from the Balaton Highland, the species is known from the Anisian of the Northern Calcareous Alps.

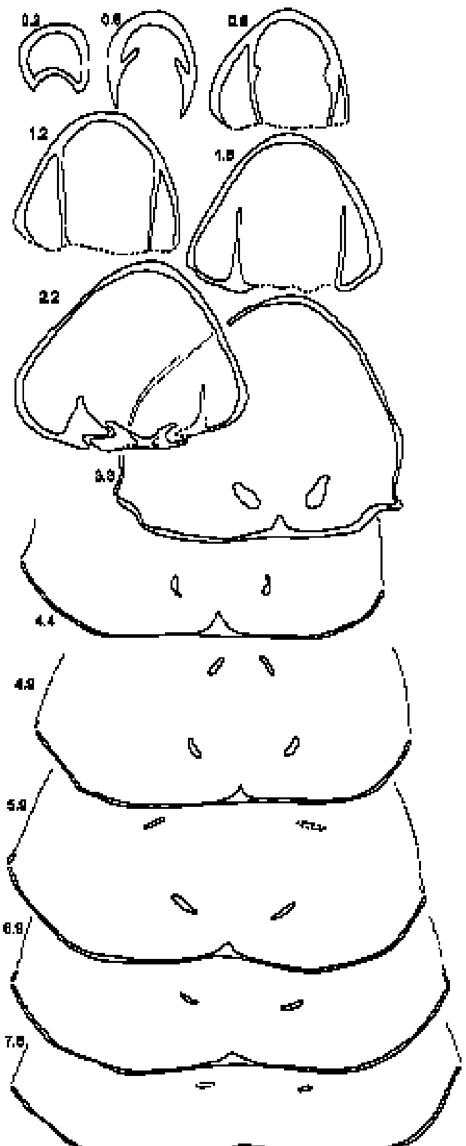

Figure Br-9. Transverse serial sections of a specimen of *Sulcatinella incrassata* from Aszófő. Distance from posterior end of shell given in mm. Length of specimen is 14.2 mm

Family Angustothyrididae DAGYS, 1972

Genus **Angustothyris** DAGYS, 1972

***Angustothyris ? angustaeformis* (BÖCKH, 1872)**

(Plate Br-I, 32–33)

1856 *Waldheimia* n. sp. — SUESS in ZEPHAROVICH, p. 369.
1872 *Waldheimia angustaeformis* BKH. n. sp. — BÖCKH, p. 160, pl. 21, fig. 20.
1890 *Waldheimia angustaeformis* BOECKH — BITTNER, p. 8, 52, pl. 36, figs. 37–40.
1895 *Waldheimia angustaeformis* BOECKH — SALOMON, p. 104, pl. 3, figs. 29–31.
1906 *Waldheimia angustaeformis* BKH. — ARTHABER, pl. 35, fig. 12.
1914 *Waldheimia angustaeformis* BKH. — ARTHABER, pl. 18, fig. 10.
1972 "*Zeilleria*" *angustaeformis* (BÖCKH) — SIBLÍK, p. 195, pl. 62, fig. 5.
? 1974 *Angustothyris angustaeformis* BOECKH — DAGYS, pl. 48, fig. 1.
1988 *Angustothyris angustaeformis* (BÖCKH, 1872) — SIBLÍK, p. 101.
1990 *Angustothyris angustaeformis* (BOECKH, 1872) — USNARSKA-TALERZAK, 681, fig. 3.
1997 *Angustothyris angustaeformis* (BÖCKH, 1872) — TORTI & ANGIOLINI, p. 168, pl. 1, figs. 35–36, pl. 2, fig. 5.
2001 *Angustothyris angustaeformis* (BÖCKH, 1872) — SIBLÍK, p. 32.

Material: Mostly slightly silicified, articulated specimens, 53 from Aszófő, 85 from Köveskál, and 9 from Felsőörs.

Dimensions: Measurements (in mm) of the holotype are as follows: L = 15.7, W = 14.2, T = 8.0. The measurements of the two figured specimens are as follows: Pl. 1, fig. 32: L = 18.4, W = 15.3, T = 9.8; Pl. 1, fig. 33: L = 21.7, W = 17.9, T = 12.2.

Description: Medium to large sized, pentagonal to rounded subpentagonal in outline. Biconvex, ventral valve more convex than dorsal one. Greatest width attained at posterior third, greatest thickness at mid-length. Beak strong, high, erect. Foramen circular, mesothyridid. Prominent, gently arched beak ridges reach lateral margin. Greatest convexity at middle of ventral valve, forming blunt ridge, whereas lateral wings flatten out. Anterior margin sharp and sulcate. Sulcus deep and wide, developing from middle of dorsal valve. Shell surface smooth.

Internal features (Figure Br-10): Pedicle collar well developed. Dental plates absent. Hinge plates not fused. Median septum lacking. Septalium deep. Sockets wide and deep. Teeth straight, undivided, with no denticle. Brachidium not preserved in the studied specimen.

Remarks: The type locality of the species is Köveskál. BÖCKH (1872) notes in the original description that distinction from the similar "*Waldheimia*" *angusta* (now assigned to *Silesiathyris*) is based on their differing size. Similar external morphology of these two species makes their distinction a persistent problem. The more pentagonal outline, the blunt "ridge" and flanking "wings" of *A. angustaeformis* may serve as diagnostic features.

DAGYS (1972, 1974) designated *angustaeformis* as the type species of his newly established genus *Angustothyris*. The diagnosis of the internal morphology was given on the basis of investigation of specimens from the Caucasus. His figured specimen displays a less developed sulcus and the described internal features also show characteristic differences from the Köveskál specimens, casting doubts about the identification of the Caucasian specimens. Further research is needed to confirm or disprove their synonymy.

Stratigraphic and geographic distribution: This species is known from Pelsonian and Illyrian strata of the Southern Alps, Western Carpathians, Anatolia, and the Caucasus. POPIEL-BARCZYK & SENKOWICZOWA (1983) recorded the species from Silesia, this is the first record from the Germanic Basin.

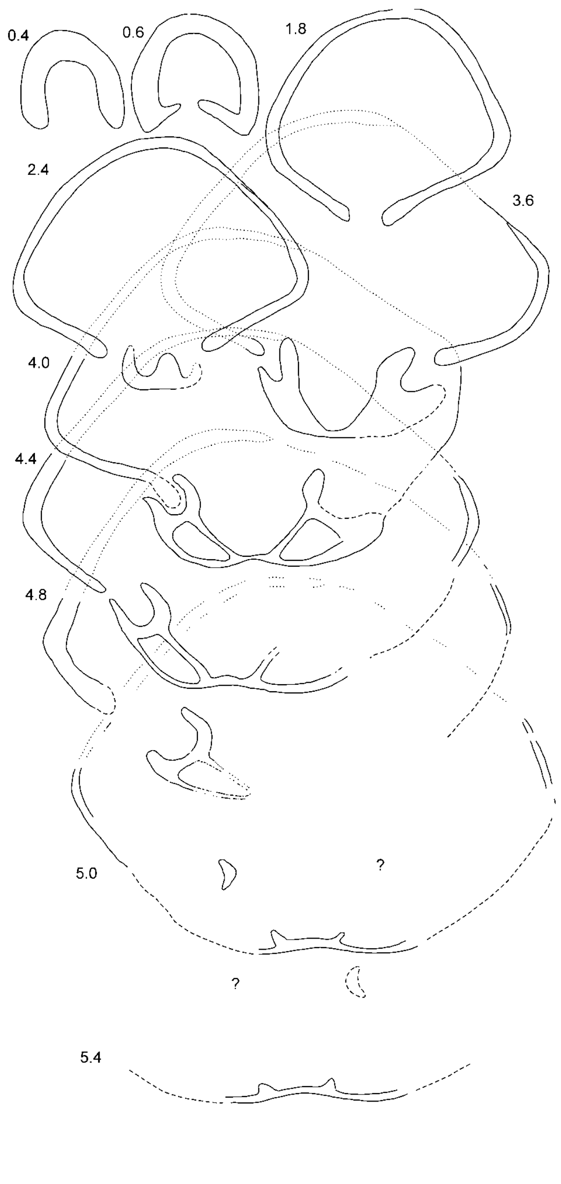

Figure Br-10. Transverse serial sections of a specimen of *Angustothyris* ? *angustaeformis* from Köveskál. Distance from posterior end of shell given in mm. Length of specimen is 18.1 mm

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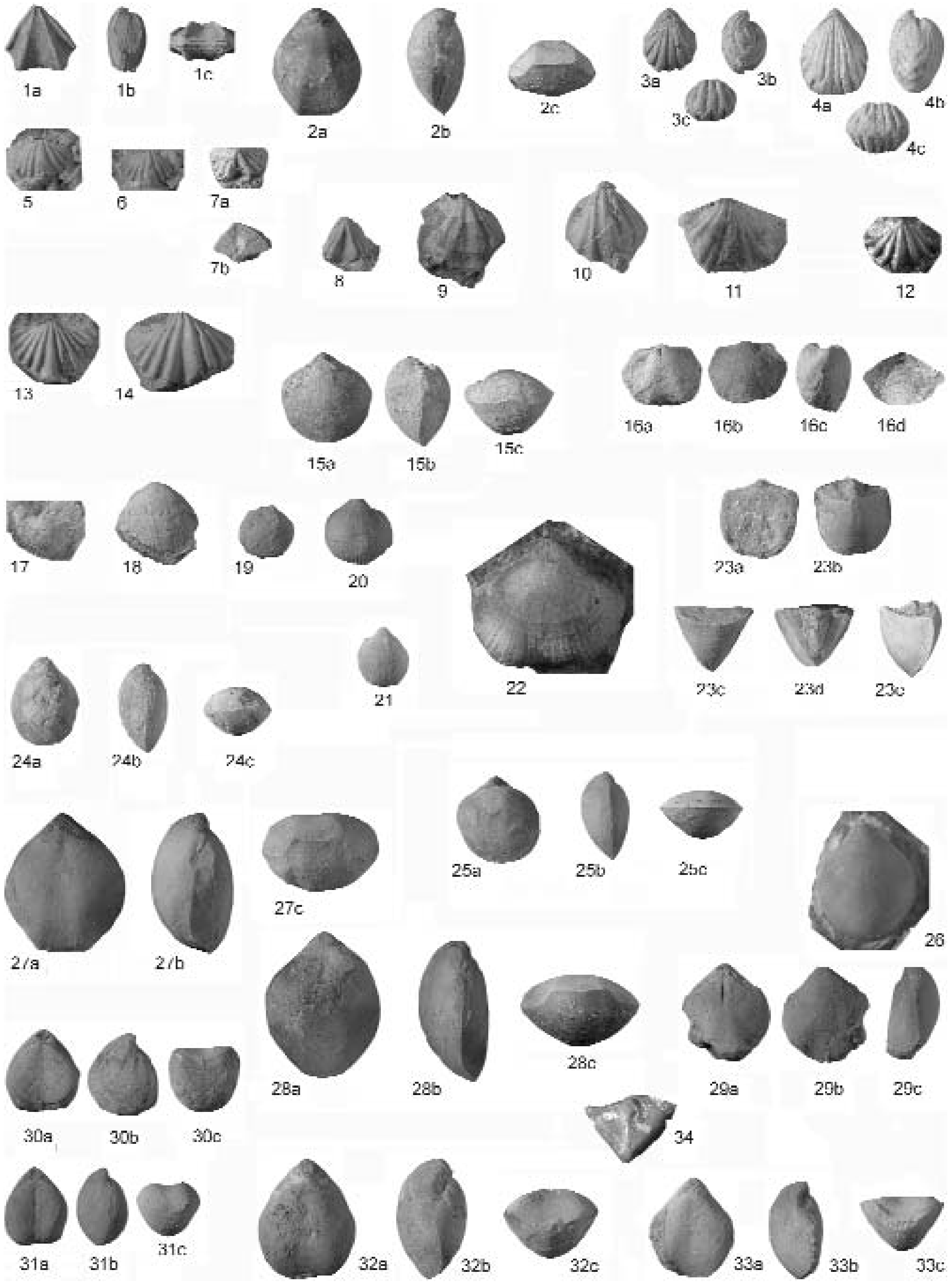
Plate Br-I.

Pelsonian brachiopods from the Balaton Highland. Figures are natural size unless otherwise indicated. Specimens were coated with ammonium-chloride before photography. Specimens are deposited in the collection of Geological and Palaeontological Department, Hungarian Natural History Museum, under the inventory numbers prefixed by M.

1. *Tetractinella trigonella* (SCHLOTHEIM, 1820); M.92.423; Felsőörs; a = dorsal view, b = lateral view, c = anterior view.
2. *Coenothyris* ? aff. *kraffti* BITTNER, 1902; M.92.435; Aszófő II, Bed 19; a = dorsal view, b = lateral view, c = anterior view.
3. *Schwagerispira schwageri* (BITTNER, 1890); M.92.424; Felsőörs; a = dorsal view, b = lateral view, c = anterior view, 2×.
4. *Schwagerispira mojsisovicsi* (BÖCKH, 1872); M.92.425; Felsőörs; a = dorsal view, b = lateral view, c = anterior view, 2×.
5. *Costispiriferina manca* (BITTNER, 1890); M.92.414; Köveskál; dorsal valve.
6. *Costispiriferina manca* (BITTNER, 1890); M.92.415; Köveskál; dorsal valve.
7. *Costispiriferina manca* (BITTNER, 1890); M.92.416; Köveskál; ventral valve; a = ventral view, b = posterior view.
8. *Costispiriferina manca* (BITTNER, 1890); M.92.417; Köveskál; ventral valve.
9. *Dinarispira avarica* (BITTNER, 1890); M.92.418; Köveskál; ventral valve.
10. *Dinarispira avarica* (BITTNER, 1890); M.92.419; Köveskál; ventral valve.
11. *Dinarispira* cf. *dinarica* (BITTNER, 1890); M.92.342; Köveskál; dorsal valve.
12. *Dinarispira* cf. *dinarica* (BITTNER, 1890); M.92.342; Köveskál; dorsal valve.
13. *Punctospirella fragilis* (SCHLOTHEIM, 1814); M.92.420; Köveskál; ventral valve.
14. *Punctospirella fragilis* (SCHLOTHEIM, 1814); M.92.421; Köveskál; dorsal valve.
15. *Mentzelia mentzeli* (DUNKER, 1851); M.92.422; Aszófő II, Bed 28; a = dorsal view, b = lateral view, c = anterior view.
16. *Mentzelia balatonica* (BITTNER, 1890); M.92.491; Felsőörs; a = dorsal view, b = lateral view, c = anterior view.
17. *Koeveskallina koeveskalyensis* (STUR, 1865); M.92.408; Aszófő II, Bed 19; dorsal valve.
18. *Koeveskallina koeveskalyensis* (STUR, 1865); M.92.409; Köveskál; dorsal valve.
19. *Koeveskallina koeveskalyensis* (STUR, 1865); M.92.410; Felsőörs; ventral valve.
20. *Koeveskallina koeveskalyensis* (STUR, 1865); M.92.411; Köveskál; ventral valve.
21. *Koeveskallina koeveskalyensis* (STUR, 1865); M.92.412; Felsőörs; ventral valve.
22. *Koeveskallina paleotypus* (LORETZ, 1875); M.92.413; Aszófő II, Bed 19; ventral valve.
23. *Thecocyrtella horogensis* n. sp.; Holotype, M.92.492; Köveskál; a = dorsal view, b = ventral view, c = anterior view, d = posterior view, e = lateral view, 2×.
24. *Coenothyris vulgaris* (SCHLOTHEIM, 1820); M.92.426; Felsőörs; a = dorsal view, b = lateral view, c = anterior view.
25. *Coenothyris vulgaris* (SCHLOTHEIM, 1820); M.92.427; Aszófő II, Bed 18; a = dorsal view, b = lateral view, c = anterior view.
26. *Coenothyris vulgaris* (SCHLOTHEIM, 1820); M.92. 436; Aszófő; ventral valve.
27. *Coenothyris* cf. *kraffti* BITTNER, 1902; M.92.429; Aszófő II, Bed 18; a = dorsal view, b = lateral view, c = anterior view.
28. *Coenothyris* cf. *kraffti* BITTNER, 1902; M.92.428; Aszófő II, Bed 22; a = dorsal view, b = lateral view, c = anterior view.
29. *Coenothyris* cf. *cuccensis* BITTNER, 1902; M.92.430; Aszófő II, Bed 28; a = dorsal view, b = lateral view, c = anterior view.
30. *Sulcatinella incrassata* (BITTNER, 1890); M.92.431; Aszófő II, Bed 19; a = dorsal view, b = lateral view, c = anterior view.
31. *Sulcatinella incrassata* (BITTNER, 1890); M.92.432; Aszófő II, Bed 19; a = dorsal view, b = lateral view, c = anterior view.
32. *Angustothyris* ? *angustaeformis* (BÖCKH, 1872); M.92.434; Köveskál; a = dorsal view, b = lateral view, c = anterior view.
33. *Angustothyris* ? *angustaeformis* (BÖCKH, 1872); M.92.433; Aszófő II, Bed 28; a = dorsal view, b = lateral view, c = anterior view.
34. *Thecocyrtella horogensis* n. sp.; Paratype, M.2002.866; Köveskál; posterior view of ventral valve, 2×.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Appendix Br-1: Tabulated stratigraphic distribution and number of collected specimens from the main Pelsonian brachiopod localities of the Balaton Highland

Taxa	Aszófő II																											Felsőörs	Köveskál	
Bed number	**2**	**3**	**4**	**5**	**7**	**8**	**9**	**10**	**12**	**13**	**15**	**16**	**17**	**18**	**19**	**20**	**21**	**22**	**23**	**24**	**25**	**26**	**27**	**28**	**29**	**30**	**31**	**40**		Lower Recoaro	Upper Recoaro
Discinisca sp.																															1
Lingula cf. *tenuissima*																															1
Norella ? sp.																														1	
Costirhynchopsis mentzeli												4	2		21	4		2	1		2	1	1	20	2	3				2	
Decurtella decurtata																		5	3		10								3	2	12
Decurtella cf. *illyrica*																					5										
Piarorhynchella trinodosi																													28		4
Volirhynchia vivida																													6	2	2
Volirhynchia projectifrons																								1	1		1	1	1?		
Volirhynchia productifrons															1																
Volirhynchia tommasii												2	3	2	13	3		2	2	1	1	1	1	27	6	2				2	
Caucasorhynchia cf. *altaplecta*																													284		1
Trigonirhynchella attilina															2														329		
Homoeorhynchia ? sp.															1	2		2	2											1	
Holcorhynchella delicatula																								1							
Tetractinella trigonella												2	2		18			8	4	5	17			4					148	262	139
Schwagerispira cf. *mojsisovicsi*															1							1?							16	3	3
Schwagerispira schwageri																1					1								1	1	
Costispiriferina manca																														1	62
Dinarispira avarica																								2						9	43
Dinarispira cf. *dinarica*																														6	1
Sinucosta pectinata																														2	5
Punctospirella fragilis							1				1				4		1	7	1	3	8	2	1							23	6
Mentzelia mentzeli			3		1	17	5	2	1			5	4	16	89	22		44	21	27	43	11	14	63	13		1		5	140	126
Mentzelia balatonica																													2		
Koeveskallina koeveskalyensis		1										2		1	3			3			2			7					14	18	17
Koeveskallina paleotypus												2		2	16	3		2						1							
Thecocyrtella horogensis																														2	
Coenothyris vulgaris	2	4	2			4	2					1	4	11	16	11	1	4	1	2	6	1	1	4					22	23	11
Coenothyris cf. *cuccensis*																								1							
Coenothyris cf. *kraffti*												3	1	9	8	4		3	3	1											
Coenothyris ? aff. *kraffti*												3	2		13	1		3	3		9	1		27	5	1				2	
Sulcatinella incrassata												1	1	2	30	5		8		1	1			1	4					1	
Angustothyris ? angustaeformis				2		2				1			1	1	6	1?		2	4	5	11	2	4	10	1				9	43	42

PELSONIAN CONODONTS FROM THE BALATON HIGHLAND

SÁNDOR KOVÁCS

INTRODUCTION

The first conodont studies in the Balaton Highland were carried out by GÖMÖRY (1966) (supervised by I. Szabó), who demonstrated the presence of Triassic conodonts in the area.

In the early seventies H. Kozur sampled several important sections in the area, and described (partly in co-authorship with H. Mostler, Innsbruck) a number of new taxa (KOZUR & MOSTLER 1970, 1971; KOZUR, in KOZUR & MOCK 1972) and established a conodont zonation for the higher Ladinian – lowermost Carnian based on the evolution of "metapolygnathoids" recognized mostly here (KOZUR 1972, KOZUR & MOSTLER 1972).

However, these studies were focused mainly on the Upper Anisian (Illyrian) – Lower Carnian interval, with less concern on the Middle Anisian (Pelsonian).

The present author began the conodont biostratigraphic investigations of the Triassic of the Balaton Highland in 1978, for the Workshop of the IUGS Triassic Subcommission in the same area, aiming the Anisian/Ladinian boundary problem. First the Felsőörs section renewed at that time was sampled bed-by-bed, including the Pelsonian part (Beds No. 43a and 44 to 83) and excluding the uppermost part (the Ladinian Nemesvámos Limestone Member). The preliminary results (also for the Pelsonian part) are contained in the contribution by SZABÓ *et al.* (1980). In the same year a small trench at Aszófő, existing at that time and corresponding to the uppermost part of the Aszófő II section, *i.e.* the main level of the *Balatonites balatonicus* fauna, was sampled (Beds No. 1–9/1978 from top to down). The whole Aszófő I and II sections were sampled in 1990 (not every beds, and on the conodont chart of Figure S-21 only those samples are shown, which yielded determinable conodonts).

The conodont biostratigraphy of the Pelsonian to Tuvalian interval of the Balaton Highland Triassic is summarized in KOVÁCS (1991), which manuscript remained unpublished. So far only the results of investigations of the Anisian/Ladinian boundary interval has been published in details (KOVÁCS 1993, 1994).

LOCALITIES

The localities providing the conodonts presented in this paper are shown in Figure C-1.

The Aszófő and Felsőörs sections that are of outstanding importance as to the conodont stratigraphy are described in the chapter "Stratigraphy" of this volume. The frequency distribution data of the determined conodont taxa in part of the more important samples is shown on Tables C-1 and C-2.

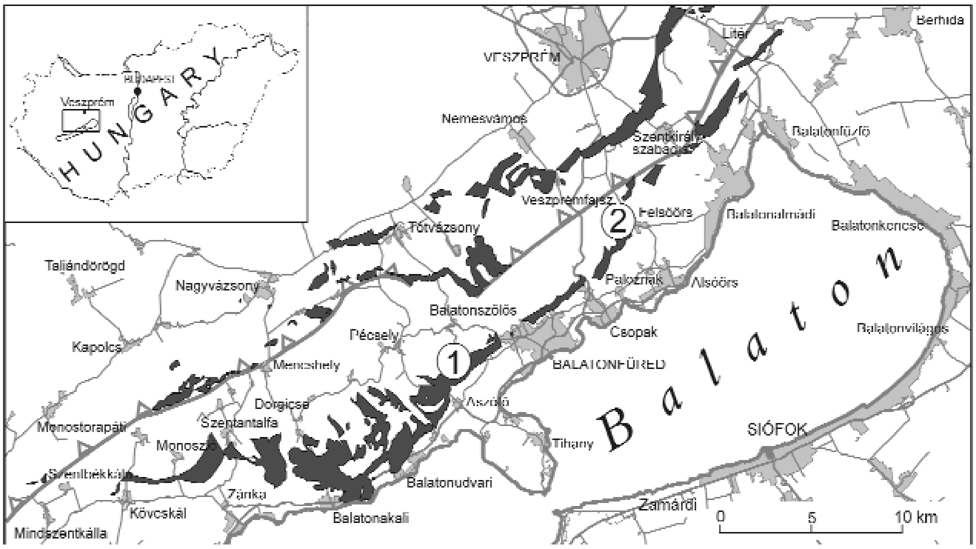

Figure C-1. Situation map showing the most important sections of the Balaton Highland providing Pelsonian conodonts. The distribution of Pelsonian formations is shown hatched, barbed line marks the Litér overtrust
1 — Aszófő, 2 — Felsőörs

Table C-1. Numerical distribution of conodonts in some more important beds in the Felsőörs sections

No. of the beds	*G. bulgarica*	*G. hanbulogi*	*G. bifurcata*	*N. kockeli*
Felsőörs				
68	6	2	–	–
67a	28	1	4	–
67	6	1	–	–
66	7	2	4	–
65	5	–	8	–
53	48	2	1	1
52	16	2	1	–
51	19	2	–	–
50	43	–	–	–
49	11	1	–	–
48	12	–	2	–
46	11	3	–	–
45	120	1	–	–
44	75	–	4	–
43/a	14	3	1	–

Table C-2. Numerical distribution of conodonts in some more important beds in the Aszófő sections

No. of the beds	*G. bulgarica*	*G. hanbulogi*	*G. bifurcata*	*G. bulgarica*→ *G. bifurcata*	*G.* aff. *"praehungarica"*
Aszófő–I (1990)					
102	4	–	3	2	–
94	3	–	4	–	–
88	15	6	14	–	–
85	8	–	7	–	–
81	14	–	11	4	3
77	2	4	5	–	–
74	1	1	1	–	–
68	2	–	3	–	–
61	1	3	1	–	–
59	3	1	1	–	–
Aszófő–II (1990)					
3	33	20	4	–	–
8	3	5	1	–	–
27	2	–	2	–	–
28	1	–	2	–	–
41	14	7	1	–	–

THE FAUNA

The extracted Pelsonian conodont material is rather rich, especially in the Felsőörs section. The complete faunal list of the determined taxa is as follows:

Gondolella bifurcata (BUDUROV & STEFANOV, 1972)
Gondolella bulgarica (BUDUROV & STEFANOV, 1975)
Gondolella hanbulogi (SUDAR & BUDUROV, 1979)
Gondolella aff. *praehungarica* KOVÁCS, 1994
Gondolella aff. *szaboi* KOVÁCS, 1983
Neospathodus kockeli TATGE, 1956 (Plate VIII, Fig. 5)
Neospathodus germanicus KOZUR, 1970 (Plate VIII, Fig. 6)
Gladigondolella malayensis budurovi KOVÁCS & KOZUR, 1980 (Plate VI, Fig. 6)

The most important and abundant species (*G. bifurcata, G. bulgarica, G. hanbulogi*) of the above assemblage will be described in detail elsewhere (KOVÁCS & RÁLISCH-FELGENHAUER, in press, based on a well-preserved material from the Anisian of the Mecsek Mts., Hungary), therefore in the present paper only some related taxonomical remarks will be given.

Concerning the photo documentation (Plates I to VIII), it should be mentioned, that SEM micrographs were prepared from the 1978 collections (both Felsőörs and Aszófő) in 1979, 1981 and 1995/96. At that time the morphological transition between *G. bulgarica* and *G. bifurcata*, as well as the presence of *G*. aff. *szaboi* and *G*. aff. *praehungarica* were not recognized. During the preparation of this manuscript we did not have opportunity to prepare new microphotographs, therefore, unfortunately, we cannot present photos of these aspects on the plates.

TAXONOMICAL REMARKS

As all form transitions are present between "*Paragondolella*" (= *Gondolella* herein) *bifurcata* BUDUROV & STEFANOV, 1972, *"Pg." bulgarica* BUDUROV & STEFANOV, 1975 and "Pg." *hanbulogi* SUDAR & BUDUROV, 1979, heavy taxonomical disputes rose up at the turn of the 70/80ies. KOZUR (in KOVÁCS & KOZUR 1980), considered *"Pg." hanbulogi* as junior synonym of *"Pg." bifurcata*, although their holotypes significantly differ, that of *"Pg." hanbulogi* being closer to *"Pg." bulgarica*. GEDIK (1975) established *G. unilobata*; however, his figured specimens correspond to all the three taxa established by Budurov and co-authors. NICORA (1977) rejected *G. unilobata* GEDIK against *"Pg." bulgarica*. Furthermore, as mentioned in the Felsőörs section, in SZABÓ *et al.* (1980), with reference to "KOVÁCS & KOZUR, in press" (but never published), *G. bifurcata* was regarded as junior synonim of *G. prava* KOZUR, 1968.

KOVÁCS & PAPŠOVÁ (1986), mainly following Budurov and co-author's principles and the morphology of the holotypes, proposed morphological criteria to distinguish the three taxa. They were based on the shape of the posterior platform end, its relationship to the last denticle of the carina, as well as on the shape and thickness of the platform margins. These can be summarized as follows:

Gondolella bulgarica: (Plate C- I, 1–6; Plate C-II, 1–4; Plate C-III, 1–3)
— platform end: pointed out, fused with the last denticle of the carina,
— platform margins: lobate on both sides, with thin margins.

Gondolella hanbulogi: (Plate C-IV, 1–5; Plate C-V, 7; Plate C-VIII, 1, 4)
— platform end: tending to be rounded, a smaller or larger brim is always present behind the last denticle of the carina,
— platform margins: lobate or tending to be parallel, with thin margins.

Gondolella bifurcata: (Plate C-V, 1–6; Plate C-VI, 1–5; C-VII, 1, 2)
— platform end: squared off or broadly rounded, with well developed brim behind the last denticle of the carina,
— platform margins: parallel, with thick margins.

It seems from these criteria, that *G. hanbulogi* (the holotype of which also derives from the Balkanide Triassic of Bulgaria, is still closer related to *G. bulgarica*. Even, part of the figured "type series" of *G. bulgarica* by BUDUROV & STEFANOV (1975), should have been included into *G. hanbulogi* (see the revision by KOVÁCS & PAPŠOVÁ 1986). However, the rich populations, investigated by KOVÁCS & PAPŠOVÁ from the Mecsek Hills, Hungary, and from the Choč Nappe of the Low Tatra Mts., are characterized by abundant transitional forms between *G. hanbulogi* and *G. bifurcata*. On the other hand, transitional forms between *G. bulgarica* and *G. bifurcata* are rare therein (see also KOVÁCS & RÁLISCH-FELGENHAUER, in press). For this reason, KOVÁCS & PAPŠOVÁ (1986), recognized them as two subspecies of the same species. More recently, GERMANI (2000), applying the morphological criteria by these authors in a detailed morphometric analysis, recognized all the three taxa in question as independent species and demonstrated their co-occurrence throughout their range, *i.e.* from the middle of the Osmani Zone to the basis of the Trinodosus Zone. Thus, the previously recognized (BUDUROV 1975, BUDUROV *et al.* 1983, BUDUROV & SUDAR 1991, KOVÁCS & PAPŠOVÁ 1986) evolutionary lineage *G. bulgarica* → *G. hanbulogi* → *G. bifurcata*, although morphologically clear, has become quite ambiguous.

As opposed to the Mecsek and Villány Triassic, however, in the Balaton Highland transitional forms between *G. bulgarica* and *G. bifurcata* predominate: the platform margins of many specimens, which according to the morphology of the posterior platform end (pointed out, fused with the last denticle of the carina) still clearly correspond to *G. bulgarica,* are tending to be parallel and thickened. Specimens, which according to the morphological criteria by KOVÁCS & PAPŠOVÁ (1986) correspond to *G. hanbulogi*, are subordinate. However, such a detailed and documented morphological study, as in the case of Mecsek (KOVÁCS & RÁLISCH-FELGENHAUER, in press) has not yet been carried out. Palaeoenvironmental studies, as done for brachiopods (PÁLFY & TÖRÖK, 1992), are also necessary to explain the differences between the Balaton Highland and Mecsek–Villány conodont faunas.

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Plate C-I.

Gondolella bulgarica (BUDUROV & STEFANOV, 1975)

(All figured specimens are from sample No. Főrs–45.)

1a–c) Early juvenile stage. Spec. No. 1.
  a) Lateral view, 100×.
  b) Lower-lateral view, 100×.
  c) Lower view, 200×.
2a–d) Juvenile stage. Spec. No. 2.
  a) Lateral view, 100×.
  b) Lower-lateral view, 100×.
  c) Lower view, 100×.
  d) Platform end, lower view 200×.
3a–d) Late juvenile stage. Spec. No. 10.
  a) Lateral view, 100×.
  b) Upper-lateral view, 100×.
  c) Upper view, 100×.
  d) Lower view, 100×.
4a–g) Late juvenile stage. Spec. No. 3.
  a) Lateral view, 100×.
  b) Upper-lateral view, 100×.
  c) Lateral-upper view, 100×.
  d) Upper view, 100×.
  e) Lower view, 100×.
  f) Platform end, lower view, 200×.
  g) Platform end, lower-lateral view, 200×.
5a–d) Early medium ontogenetic stage. Spec. No. 9.
  a) Lateral view, 100×.
  b) Upper-lateral view, 100×.
  c) Upper view, 100×.
  d) Lower view, 100×.
6a–f) Medium ontogenetic stage. Spec. No. 6.
  a) Lateral view, 100×.
  b) Upper-lateral view, 100×.
  c) Upper view, 100×.
  d) Lower view, 100×.
  e) Platform end, lower view, 200×
  f) Platform end, lower-lateral view, 200×.

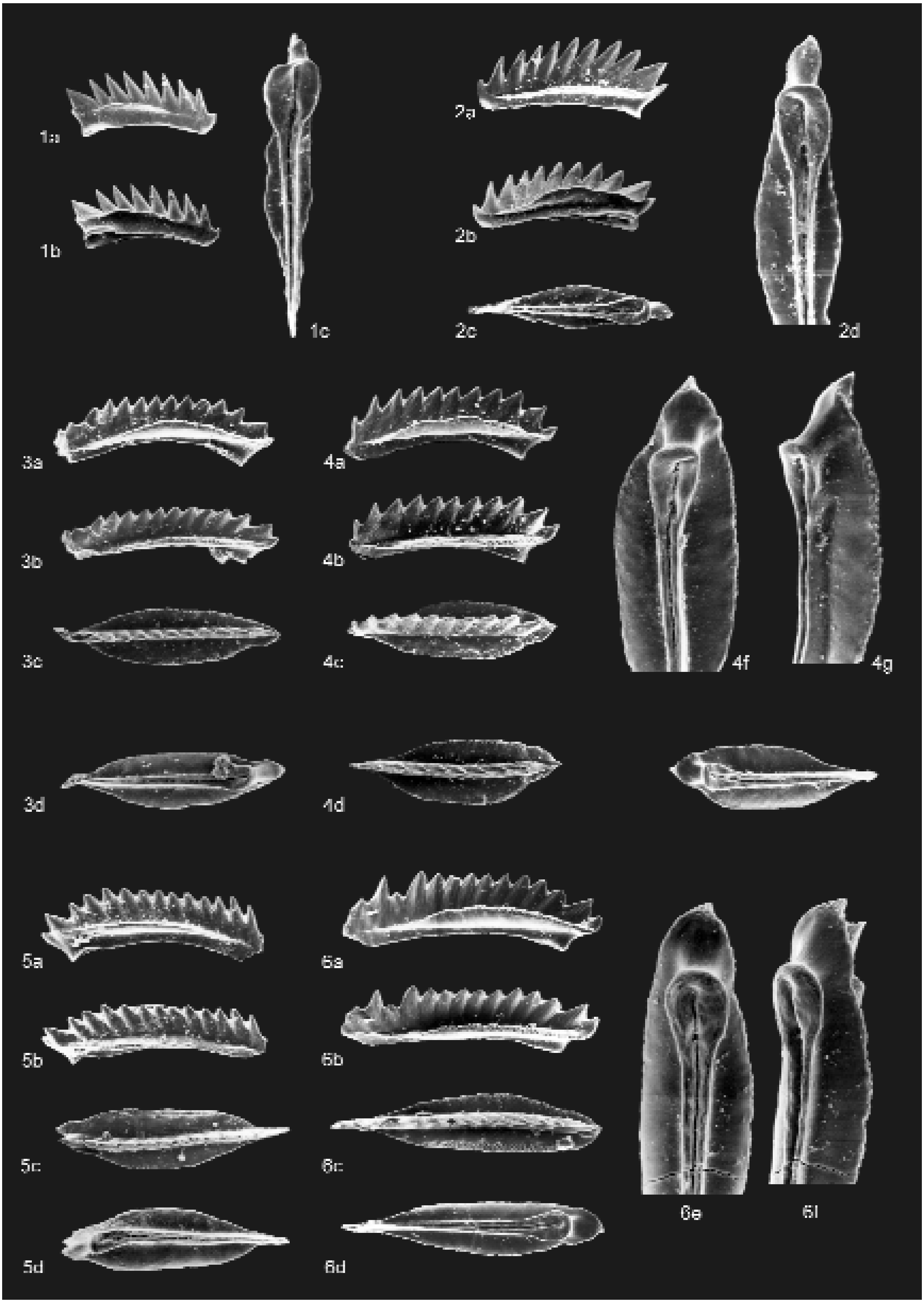
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Plate C-II.

Gondolella bulgarica (BUDUROV & STEFANOV, 1975)

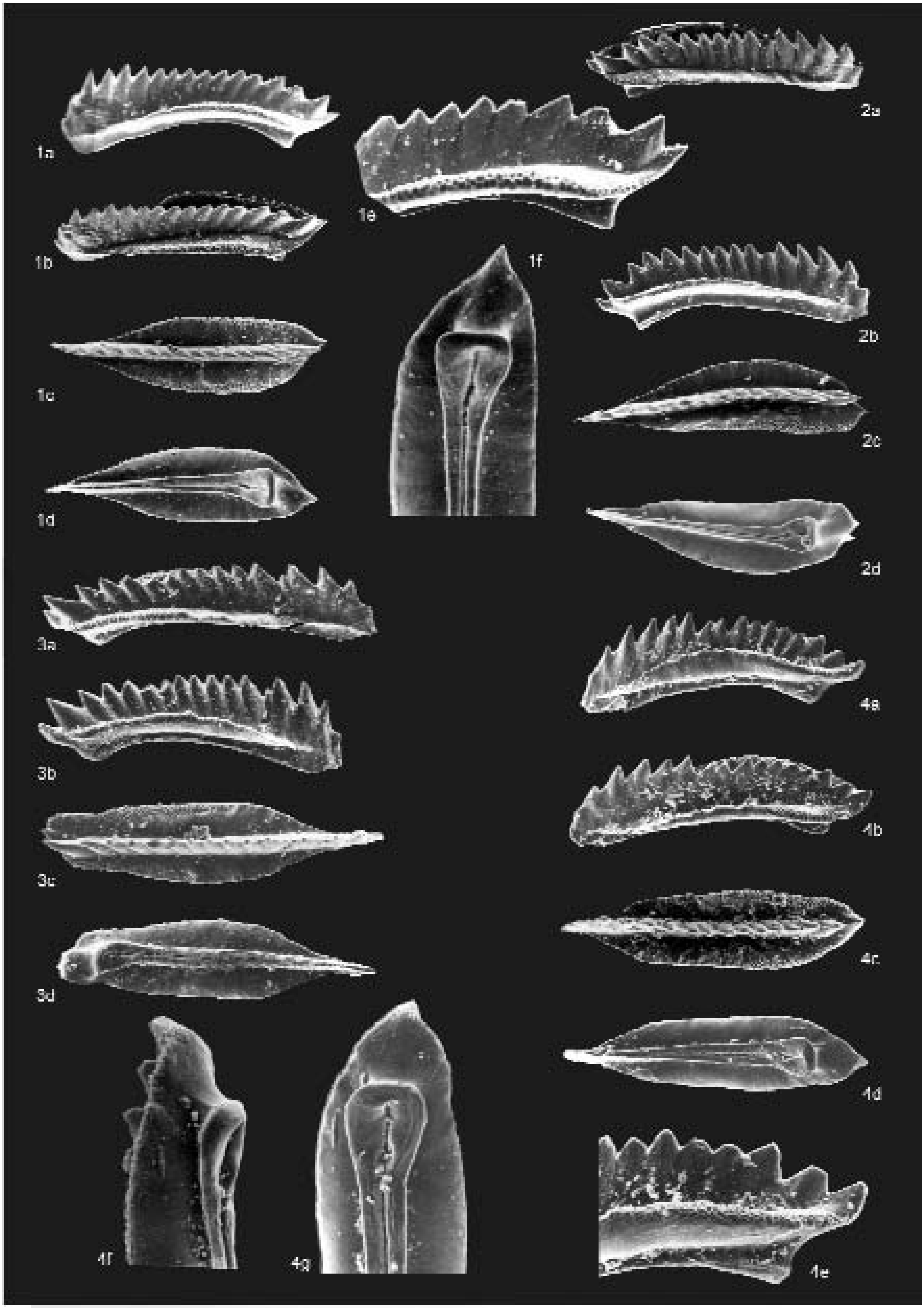
(All figured specimens are from sample No. Főrs–45.)

1a–f) Medium ontogenetic stage. Spec. No. 12.
a) Lateral view, 100×.
b) Upper-lateral view, 100×.
c) Upper view, 100×.
d) Lower view, 100×.
e) Platform end, upper-lateral view, 200×.
f) Platform end, lower view, 200×.

2a–d) Medium ontogenetic stage. Spec. No. 5.
a) Upper-lateral view, 100×.
b) Lateral view, 100×.
c) Upper view, 100×.
d) Lower view, 100×.

3a–d) Late medium ontogenetic stage. Spec. No. 8.
a) Upper-lateral view, 100×.
b) Lateral view, 100×.
c) Upper view, 100×.
d) Lower view, 100×.

4a–g) Subadult stage. Spec. No. 4.
a) Lateral view, 100×.
b) Upper-lateral view, 100×.
c) Upper view, 100×.
d) Lower view, 100×.
e) Platform end, lateral view, 200×.
f) Platform end, lower-lateral view, 200×.
g) Platform end, lower view, 200×.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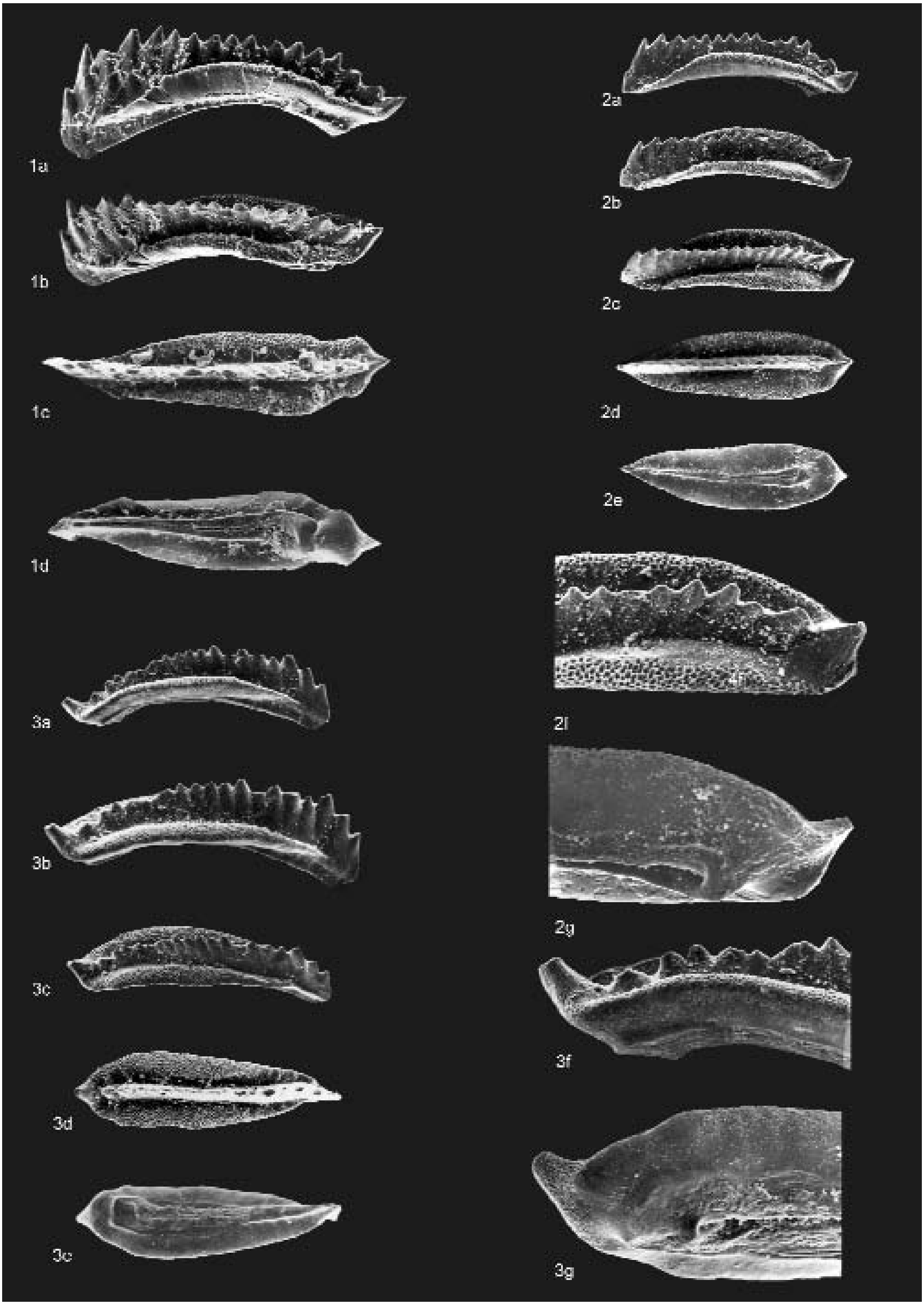
4c
4d
4e
4f
4g

Plate C-III.
Gondolella bulgarica (BUDUROV & STEFANOV, 1975)

1a–d) Subadult stage. Spec. No. 13, sample No. Főrs–45.
  a) Lateral view, 100×.
  b) Lateral-upper view, 100×.
  c) Upper view, 100×.
  d) Lower view, 100×.
2a–g) Subadult stage, Spec. No. 16, sample No. Aszófő–6/78.
  a) Lateral view, 65×.
  b) Upper-lateral view, 65×.
  c) Lateral-upper view, 65×.
  d) Upper view, 65×.
  e) Lower view, 65×.
  f) Platform end, lateral-upper view, 160×.
  g) Platform end, lower-lateral view, 200×.
3a–g) Hyperadult stage. Spec. No. 15, sample No. Aszófő–6/78.
  a) Lateral view, 50×.
  b) Lateral-upper view, 65×.
  c) Upper-lateral view, 50×.
  d) Upper view, 50×.
  e) Lower view, 50×.
  f) Platform end, lateral view, 135×.
  g) Platform end, lateral-lower view, 145×.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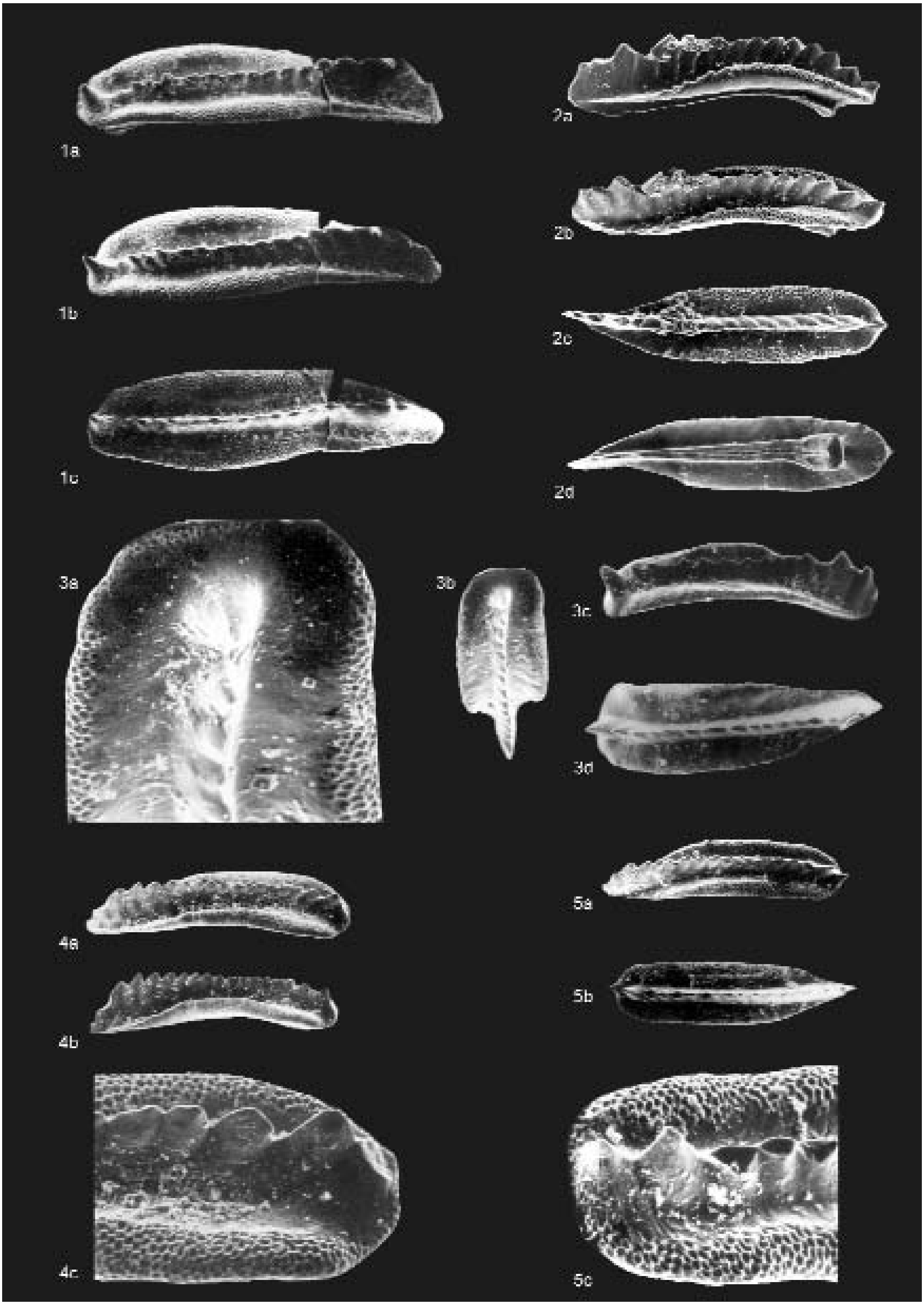
3f
3g

Plate C-IV.
Gondolella hanbulogi (SUDAR & BUDUROV, 1979)

1a–c) Adult stage. Spec. No. 15/81, sample No. Főrs–72.
a) Lateral-upper view, 65×.
b) Frontal lateral-upper view, 65×.
c) Upper view, 65×.
2a–d) Medium ontogenetic stage, Spec. No. 14/95, sample No. Főrs–45. Form still close to *G. bulgarica.*
a) Lateral view, 100×.
b) Upper-lateral view, 100×.
c) Upper view, 100×.
d) Lower view, 100×.
3a–d) Adult stage. Spec. No. 17/81, sample No. Főrs–72. Form with *bifurcata*-type platform outline, but with thin margins.
a) Platform end, posterior-upper view, 240×.
b) Posterior-upper view, 65×.
c) Upper-lateral view, 65×.
d) Upper view, 65×.
4a–c) Subadult stage, Spec. No. 5/81, sample No. Főrs–72.
a) Lateral-upper view, 65×.
b) Upper-lateral view, 65×.
c) Platform end, lateral-upper view, 265×.
5a–c) Subadult stage, Spec. No. 16/81, sample No. Főrs–72.
a) Lateral-upper view, 65×.
b) Upper view, 65×.
c) Platform end, lateral-upper view, 265×.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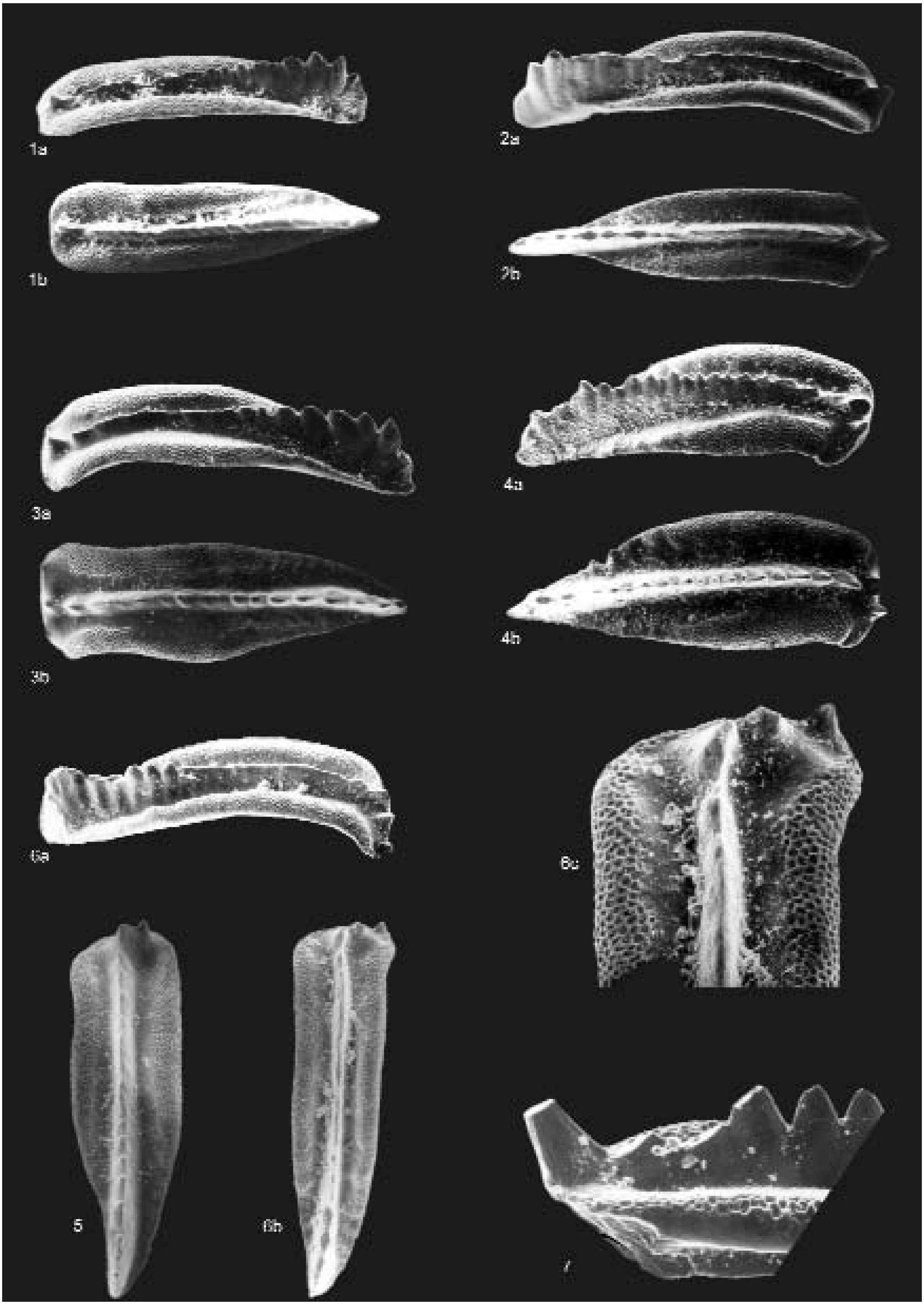
1c
2a
2b
2c
2d
3a
3b
3c
3d
4a
4b
4c
5a
5b
5c

Plate C-V.
Gondolella bifurcata (BUDUROV & STEFANOV, 1972), 1–6.
Gondolella hanbulogi (SUDAR & BUDUROV, 1979), 7.

1a–b) Subadult stage. Spec. No. 11, sample No. Főrs–78.
a) Upper-lateral view, 65×.
b) Upper view, 65×.
2a–b) Subadult stage. Spec. No. 12, sample No. Főrs–78.
a) Lateral-upper view, 65×.
b) Upper view, 65×.
3a–b) Adult stage. Spec. No. 13, sample No. Főrs–78.
a) Lateral-upper view, 65×.
b) Upper view, 65×.
4a–b) Adult stage. Spec. No. 14, sample No. Főrs–78.
a) Lateral-upper view, 65×.
b) Upper view, 65×.
5. Adult stage. Spec. No. 1/79, sample No. Főrs–80. (Specimen figured in SZABÓ *et al.* 1980, Pl. 59, fig) 12 as "*G. prava* KOZUR, 1968") Upper view, 65×.
6a–c) Adult stage. Spec. No. 2/79, sample No. Szabó I -10. (Specimen figured in SZABÓ *et al.* 1980, Pl. 59, fig) 13a–b as "*G. prava* KOZUR, 1968")
a) Lateral-upper view, 65×.
b) Upper view, 65×.
c) Platform end, upper view, 175×.
7. *Gondolella hanbulogi* (SUDAR & BUDUROV, 1979). Spec. No. 4, sample No. Főrs–72. Platform end, upper-lateral view, 265×. (Detail of a specimen figured on Plate C-VIII., 4a–d).


1a
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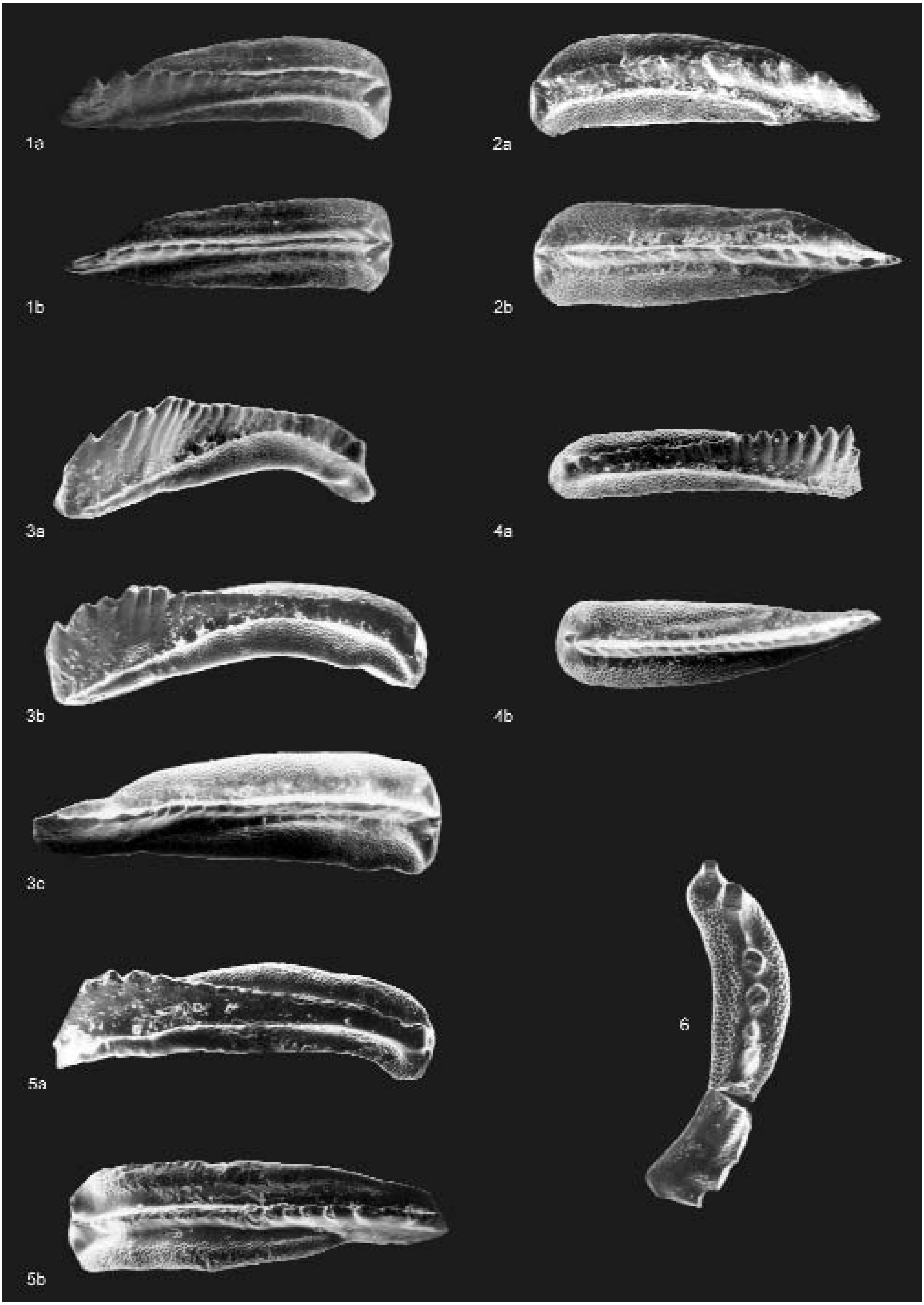
1b
2b
3a
4a
3b
4b
6a
6c
5
6b

Plate C-VI.

Gondolella bifurcata (BUDUROV & STEFANOV, 1972), 1–5.
Gladigondolella malayensis budurovi KOVÁCS & KOZUR, 1980, 6.

1a–b: Adult stage. Spec. No. 6, sample No. Szabó I–10.
a) Lateral-upper view, 65×.
b) Upper view, 65×.
2a–b) Adult stage. Spec. No. 7, sample No. Szabó I–10.
a) Lateral-upper view, 65×.
b) Upper view, 65×.
3a–c) Hyperadult stage. Spec. No. 8, sample No. Szabó I–10.
a) Frontal-lateral view, 60×.
b) Lateral-upper view, 62 ×.
c) Upper view, 65 ×.
4a–b) Subadult stage. Spec. No. 9, sample No. Szabó I–10.
a) Lateral-upper view, 65×.
b) Upper view, 65×.
5a–b) Adult stage. Spec. No. 10, sample No. Szabó I–10.
a) Lateral-upper view, 65×.
b) Upper view, 65×.
6. *Gladigondolella malayensis budurovi* KOVÁCS & KOZUR, 1980. Spec. No. 1, sample No. Főrs–78. Lateral-upper view, 65×.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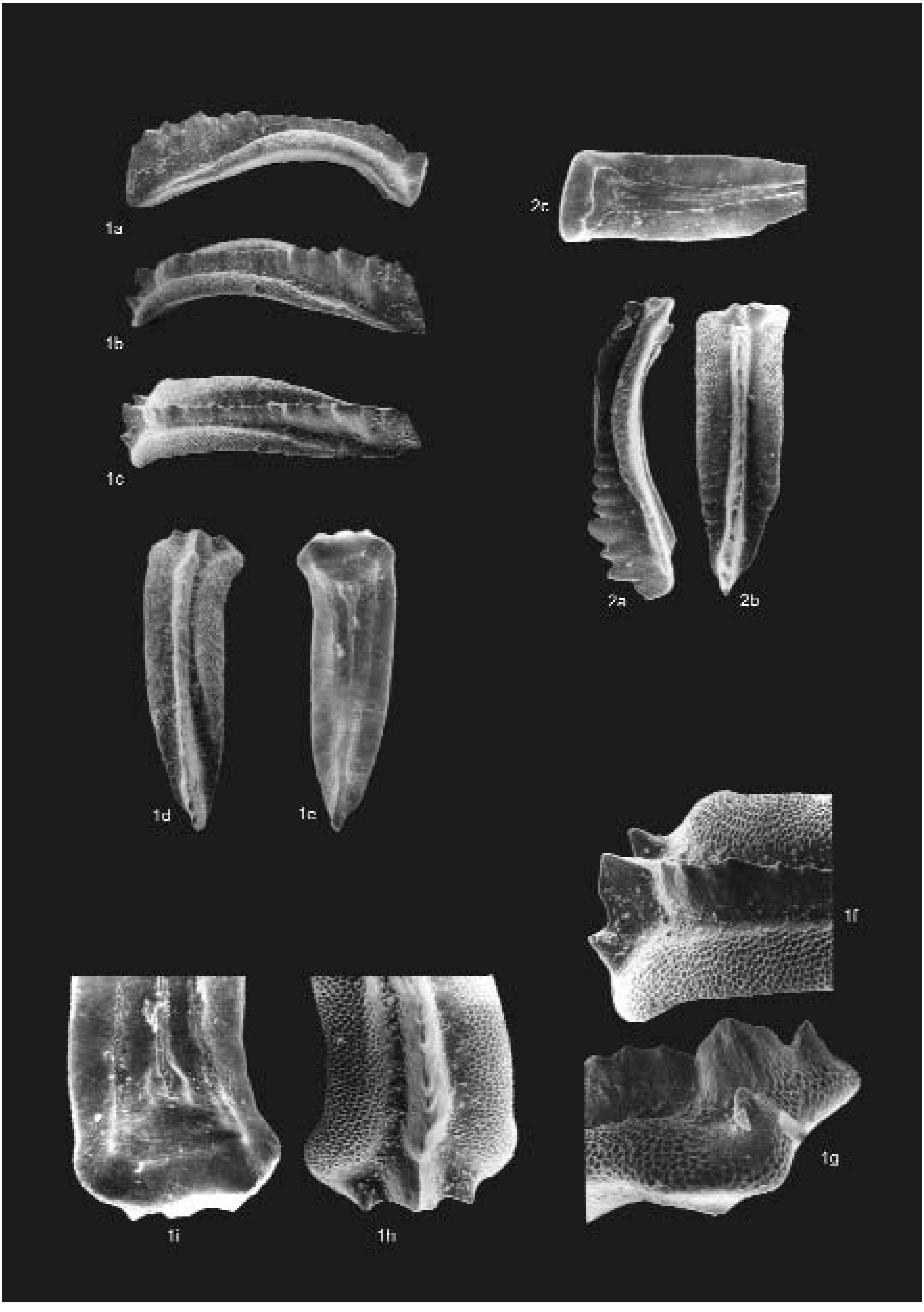
4a
3b
4b
3c
6
5a
5b

Plate C-VII.

Gondolella bifurcata (BUDUROV & STEFANOV, 1972), 1–2

1a–i) *Gondolella bifurcata* (BUDUROV & STEFANOV, 1972). Spec. No. 3, sample No. Szabó I–10. Typical form, with bifurcated posterior end.
a) Lateral view, 50×.
b) Upper-lateral view, 50×.
c) Lateral-upper view, 50×.
d) Upper view, 50×.
e) Lower view, 50×.
f) Platform end, lateral-upper view, 200×.
g) Platform end, upper-lateral view, 200×.
h) Platform end, upper view, 135×.
i) Platform end, lower view, 135×.

2a–c) *Gondolella bifurcata* (BUDUROV & STEFANOV, 1972) Spec. No. 3/79, Sample No. Szabó I–10. Asymmetrical form.
a) Lateral view, 65×.
b) Upper view, 65×.
c) Lower view, 65×.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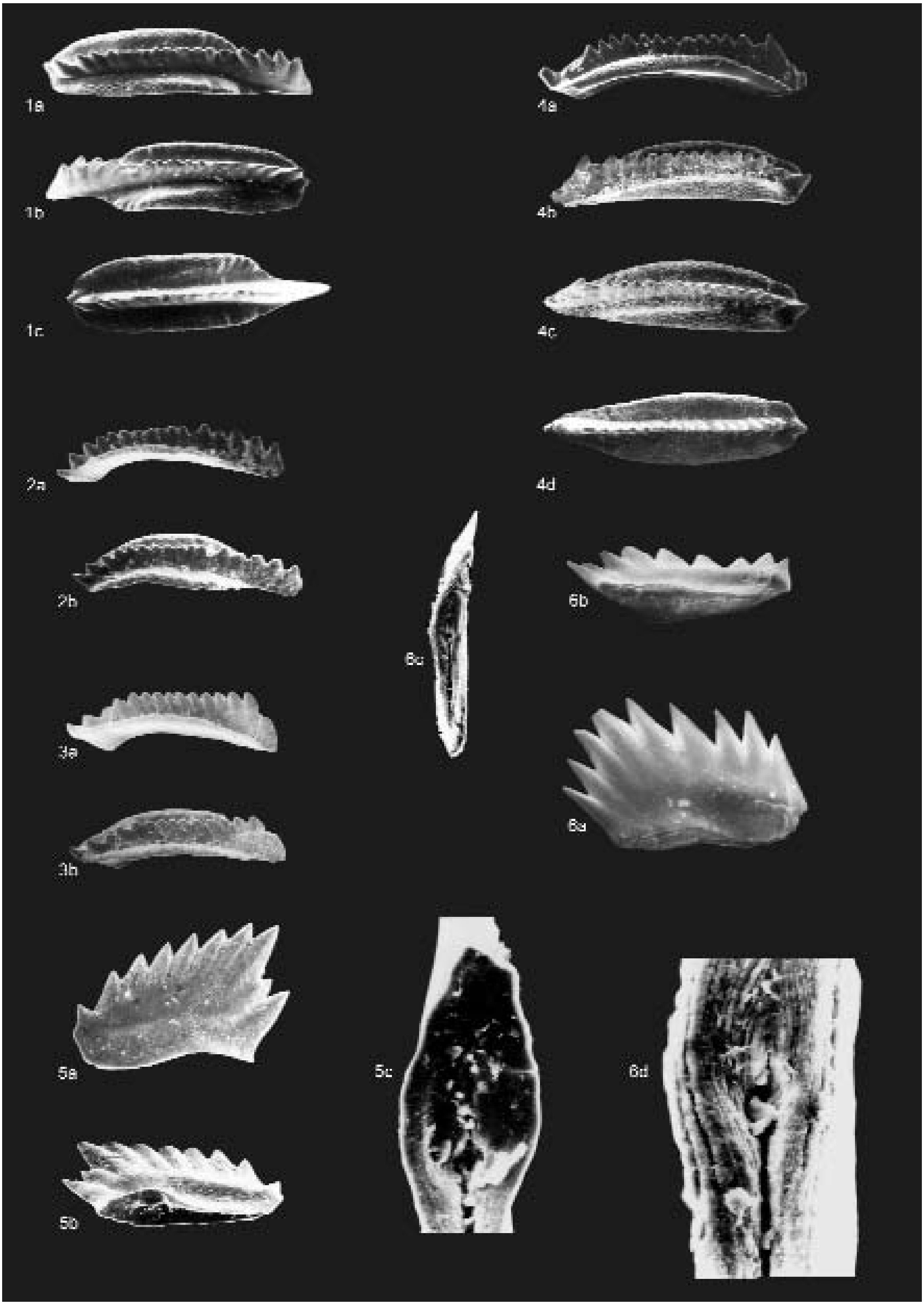
1i
2a
2b
2c

Plate C-VIII.

1a–c) *Gondolella hanbulogi* (SUDAR & BUDUROV, 1979). Spec. No. 3, sample No. Főrs–78.
  a) Upper-lateral view, 65×.
  b) Lateral-upper view, 65×.
  c) Upper view, 65×.
2a–b) *Gondolella bulgarica* (BUDUROV & STEFANOV, 1975). Spec. No. 9, sample No. Főrs–72.
  a) Lateral view, 65×.
  b) Lateral-upper view, 65×.
3a–b) *Gondolella bulgarica* (BUDUROV & STEFANOV, 1975). Spec. No. 1/79, sample No. Főrs–45.
  a) Lateral view, 65×.
  b) Lateral-upper view, 65×.
4a-d) *Gondolella hanbulogi* (SUDAR & BUDUROV, 1979). Spec. No. 4, sample No. Főrs–72.
  a) Lateral view, 65×.
  b) Upper-lateral view, 65×.
  c) Lateral-upper view, 65×.
  d) Upper view, 65×.
5a–c) *Neospathodus kockeli* (TATGE, 1956). Spec. No. 1, sample No. Szabó I–10. (Specimen figured in SZABÓ *et al.* 1980, Pl. 59, figs. 10a–b).
  a) Lateral view, 135×.
  b) Lower-lateral view, 135×.
  c) Basal pit, enlarged, 480×.
6a–d) *Neospathodus germanicus* KOZUR, 1970. Spec. No. 1, sample No. Főrs–81. (Specimen figured in SZABÓ *et al.* 1978, Pl. 59, figs. 9a–b).
  a) Lateral view, 135×.
  b) Lower-lateral view, 135×.
  c) Lower view, 135×.
  d) Basal pit, enlarged, 650×.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MICROFACIES OF THE PELSONIAN FORMATIONS ON THE BALATON HIGHLAND

GYÖRGY LELKES & ATTILA VÖRÖS

INTRODUCTION

In spite of the diverse, environmentally easy to evaluate and esthetically “nice and enjoyable” character of rocks of the Pelsonian formations in the Balaton Highland, there are only a few papers published on the microfacies characteristics of the area. Following the appearance of the classical stratigraphical-palaeontological “Balaton monograph” by L. LÓCZY (1913, 1916) and after the long period of time of about half a century without published scientific results, the first paper dealing with microfacies aspects, came out as late as in 1980 (SZABÓ *et al.* 1980). In the eighties, as a result of geological mapping and “National Geological Key Section Programme” performed by the Geological Institute of Hungary, a very significant amount of core/surface samples were collected and investigated from various points of view. One of them included thin-section microfacies analyses. In spite of the thorough, labour-consuming thin-section studies, based on the investigation of several hundreds or perhaps one thousand slides, results of the microfacies analyses, apart from a few ones (ORAVECZ-SCHEFFER 1980, 1987), went unpublished to the archives. The project “Middle Triassic basin evolution of the Balaton Highland (Hungary), based on sedimentological and palaeoecological studies” sponsored by the National Scientific Research Fund (OTKA) and led by A. Vörös yielded two papers including parts on microfacies characteristics (BUDAI *et al.* 1993, VÖRÖS *et al.* 1997).

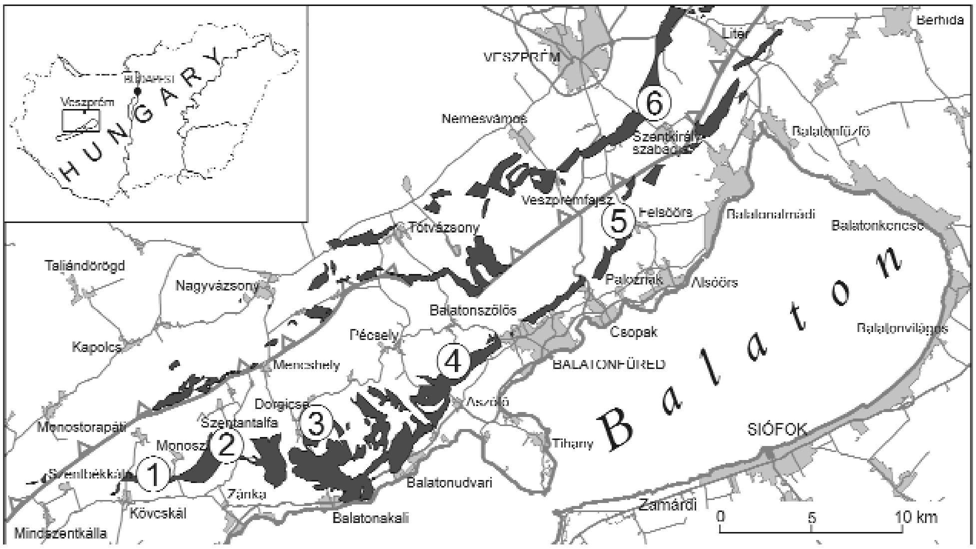

Figure M-1. Situation map showing the most important localities of the Balaton Highland providing Pelsonian microfacies samples. The distribution of Pelsonian formations is shown dark shaded (barbed line marks the Litér overthrust)

1 — Köveskál, Horog-hegy; 2 — Szentantalfa Szaf–1 borehole; 3 — Dörgicse Drt–1 borehole; 4 — Aszófő, Farkó-kő; 5 — Felsőörs, Forrás-hegy (Malom-völgy); 6 — Szentkirályszabadja, airport quarry

In the present work microfacies characteristics of the formations of the Pelsonian substage on the Balaton Highland will be summarised and documented by photomicrographs taken on thin sections from the following surface/borehole sections: Köveskál (Horog-hegy), Szentantalfa–1, Dörgicse–1, Aszófő (Farkó-kő) I and II, Felsőörs (Forrás-hegy = Malom-völgy) and Szentkirályszabadja, (“military airport”) (Figure M-1). Lithostratigraphic subdivision of these sections are shown in Figure G-2 in the chapter “Geological setting” and in Figures S-3, S-5, S-9, S-11 and S-12 in the chapter “Stratigraphy” of this volume. Major lithostratigraphic units (formations) provide the framework for the description of microfacies characteristics.

Table M-1. Distribution of microfacies types in Dörgicse–1 borehole

	1	2	3	4	5	6
75.8 m						+
76.8 m	+					
77.2 m	+					
79.0 m						+
79.2 m						+
80.0 m					+	
81.5 m						+
81.8 m					+	
82.2 m						+
82.7 m						+
83.4 m						+
84.9 m						+
88.2 m				+		
89.2 m				+		+
93.9 m		+				
97.5 m			+			+
100.0 m	+					
102.4 m				+	+	
103.8 m				+		
105.0 m			+	+	+	
106.6 m				+		
106.8 m						+
108.8 m						+
110.8 m	+					
112.7 m	+					
114.7 m			+			
115.1 m			+			
115.4 m	+			+		
116.8 m	+			+		
118.3 m				+		
119.4 m				+		
120.5 m				+		
121.4 m				+		
122.4 m				+		
123.0 m				+		
123.3 m				+		
124.4 m				+	+	
124.5 m				+		
125.0 m					+	
125.5 m	+					
126.3 m				+		+
127.0 m	+			+		
128.1 m	+					
129.3 m	+					
130.2 m	+					
131.5 m				+		
134.0 m	+					
134.6 m					+	
135.8 m						+
137.1 m	+					
138.4 m				+		
138.6 m	+					
139.7 m					+	
141.2 m	+					

1. microoncoidal GRST/PCKST
2. Dasycladacean GRST/PCKST
3. Fenestral peloidal stromatolite deposits
4. Calichified brecciated microbial mats
5. Vadolite-vadose carbonates
6. Recrystallized carbonates

DESCRIPTION OF MICROFACIES

Tagyon Formation

Rocks belonging to the Tagyon Formation, one of the most characteristic Pelsonian lithostratigraphic units in the Balaton Highland, came from boreholes Szentantalfa–1 and Dörgicse–1 and from several surface outcrops from the quarry "military airport" at Szentkirályszabadja.

Stratotype of the Tagyon Formation is the Dörgicse–1 borehole section (BUDAI *et al.* 1990, 1993). Microfacies types of the formation, on the basis of thin-section studies of the stratotype section, are as follows:

— *Microoncoidal grainstone/packstone* (Plate M-I, 1). Abundant. Microoncoids mainly of 0.1–1.0 mm grain size form the vast majority of the components. In the bigger microoncoids dispersed dolomite rhombohedra around 0.06 mm can often be seen. Other components are represented by benthonic foraminifers, mollusc (gastropod) shell-fragments, dasycladaceans, echinoderms and ostracods. In general their quantity is low, from among them foraminifers and dasycladaceans are relatively frequent. The cement is almost exclusively sparry calcite, developed as (1) centripetally oriented elongated crystals and (2) inequigranular mosaic crystals. In a few samples some micritic matrix can also be seen. Pores of various size and shape are filled with cement of aforementioned types.

— *Dasycladacean grainstone/packstone* (Plate M–I, 2). Rare. Dasycladacean skeletal elements are abundant, partly recrystallized but well recognizable.

— *Vadose carbonates – vadolite*. Common. A characteristic feature of this rock-type is the frequent normal or reverse graded bedding (Plate M–I, 3). The main components are vadoids (sensu PERYT 1983) of 2–15 mm in size (Plate M-I, 3, 4). Normal or composite peloidal-micritic grains (Plate M- I, 5), or infrequently bioclasts of algal or molluscan origin (Plate M-I, 5) function as a nucleus. This in turn is coated by a thin, more or less isopachous, but occasionally non-isopachous cortex (Plate M-I, 5). Vadoids frequently exhibit point contact or meniscus cement (Plate M-I, 5). The interstices are partly filled by small microids (peloids), partly by calcite crystals of centripetally oriented elongated appearance or of mosaic morphology.

— *Fenestral, peloidal stromatolite* either with bioclastic-fenestral or homogeneous micritic-peloidal development. Medium frequency. The bioclasts are rare; the fenestrae are medium or abundant. Bioclasts are represented by benthonic foraminifers and ostracods. Geopetal pore-fillings are visible in some of the fenestrae (Plate M-I, 6).

— *Calichified/brecciated microbial mats* (medium) and *vadose carbonate crusts and calcretes* (rare). Due to subaerial exposure the intertidal microbial mat underwent "calichification" which resulted in "bleaching", micritization and partial recrystallization and brecciation. The vadose carbonate crusts are unbroken or brecciated (Plate M-II, 1).

— *Recrystallized carbonates*. Common. The original texture has largely or totally been obliterated. The majority of samples consists of inequigranular, hypidiotopic/idiotopic sparite.

The distribution of microfacies types of Dörgicse–1 borehole is shown in Table M-1.

The microfacies types may be grouped according to their depositional and early diagenetic environments. The microoncoidal and the Dasycladacean grainstone/packstone represent euphotic depositional environment and **marine phreatic** early diagenetic conditions. The fenestral microbial mat deposits were formed on the tidal flat. The calichified microbial mats indicate subaerial exposure of the tidal flat and **marine vadose** diagenetic circumstances, whereas the vadose carbonates (vadolites) can be connected to **meteoric vadose** environment. The main facies types frequently fluctuated in the succession of the Tagyon Formation exposed in the Dörgicse (Drt–1) borehole as it is shown in Figure M-2.

The predominant part of samples from Szentantalfa–1 borehole proved to be *microoncoidal grainstones/packstones* (Plate M-II, 2), analogous with the microfacies type 1 in Dörgicse–1 borehole, whereas a little part of them exhibits recrystallized, obliterated texture, corresponding to microfacies type 6 in borehole Dörgicse–1.

Surface samples from the abandoned quarry at the military airport at Szentkirályszabadja provided a spectacular Pelsonian microfacies in the Balaton Highland. The majority of the studied samples are *micro/pisooncoidal – peloidal grainstones* and may contain various *bioclasts* and *vadoids/vadose carbonate crusts* of various frequency (Plate M-II, 3). Bioclasts include skeletal elements of undetermined calcified cyanobacteria (Plate M-II, 4, 5), dasycladaceans (Plate M-II, 6), unbroken gastropods (Plate M-II, 7), other molluscs including rare cephalopods (Plate M-III, 1), benthonic foraminifers, echinoderms and ostracods. From among them the first four is relatively frequent. Vadoids are generally of pisoid size and are quite numerous in some of the samples (Plate M-III, 2–5). Other, less common microfacies types include dasycladacean grainstones (Plate M-III, 6), fenestral microoncoidal grainstones (Plate M-IV, 1). Recrystallized, obliterated textures and rare, stromatolite/microbialite-like textures also occur scarcely (Plate M-IV, 2).

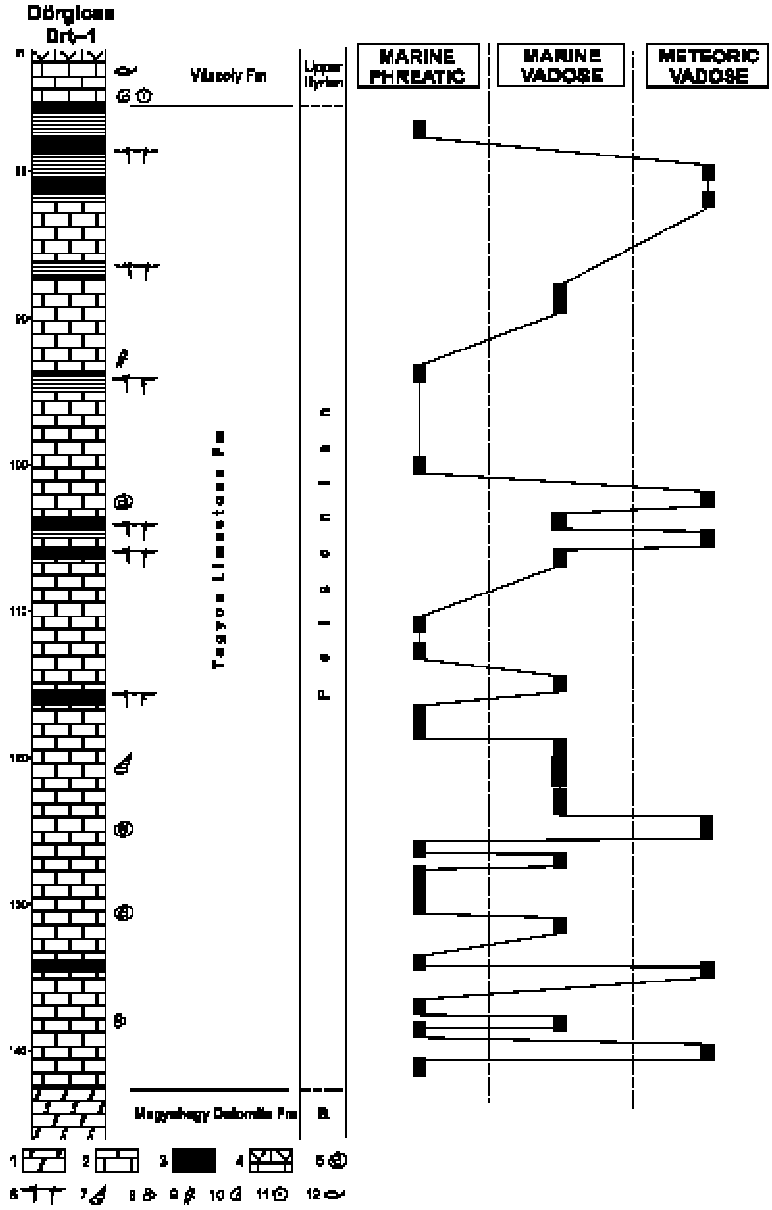

Figure M-2. Vertical change of early diagenetic environments (as deduced from the evaluation of microfacies types) in the Tagyon Formation exposed in the lower part of Dörgicse (Drt–1) borehole (stratigraphic column after BUDAI et al. 1990)

Legend: 1 — platform dolomite; 2 — subtidal limestone (akin to Lofer cycle C member); 3 — peritidal limestone (akin to Lofer cycle B member); 4 — limestone and tuffaceous limestone of basin facies; 5 — oncoids; 6 — desiccation cracks; 7 — gastropods; 8 — foraminifers; 9 — dasycladaceans; 10 — ammonoids; 11 — crinoid fragments; 12 — brachiopods; B. = Bithynian

The above microfacies features essentially support the facies interpretation of the Tagyon Formation given by BUDAI (1993) and HAAS (1998): the formation is represented by shallow marine, cyclic, peritidal-subtidal carbonate platform sediments deposited in normal marine, inner platform environment. Nevertheless, microfacies types 3–5 in the Dörgicse (Drt–1) borehole section and the frequency of vadolites/vadose carbonate crusts in the quarry section at Szentkirályszabadja clearly indicate that vadose conditions must have been more widespread than it was previously assumed (BUDAI *et al.* 1993, VÖRÖS *et al.* 1997) and this must be reflected in the facies/environmental interpretation in a more pronounced way.

Felsőörs Formation

Surface sections exposing the Felsőörs Formation in the Balaton Highland are found at Felsőörs (Forrás-hegy), Aszófő (Farkó-kő) I and II and Köveskál (Horog-hegy). The Felsőörs Formation is subdivided to the Forráshegy, Horoghegy and Bocsár Members (BUDAI 1993) which exhibit different microfacies types.

The microfacies of the Forráshegy Member (beds 44–67) at Felsőörs, Forrás-hegy is *spiculitic micrite,* wackestone/packstone (standard microfacies: SMF–1, sensu FLÜGEL 1972, 1978) (Plate M-IV, 3). The main rock-forming components are sponge spicules dominating over a few other biogenic grains such as fragments of echinoderms, molluscs and brachiopods, as well as ostracods and benthonic foraminifers. The micrite matrix has been recrystallized to microsparite or finely crystalline sparite.

Filamentous micrite (SMF–3) appears as frequent microfacies type in the upper part of the section (beds 67–81), though an early occurrence in bed 46 was also recorded.

Bioclastic (crinoid–brachiopod–mollusc) micrite mainly of packstone, rarely wackestone texture (SMF–5) (Plate M-IV, 4, 5) represents the Horoghegy Member (beds 68–81) in the Felsőörs, Forrás-hegy section. The coarse to very coarse-grained skeletal elements of echinoderms (mostly crinoidal particles) (Plate M-IV, 6, 7), brachiopods (Plate M-IV, 8; Plate M-V, 1) and molluscs (gastropods) (Plate M-V, 2) are the main rock-forming components. Molluscan bioclasts have completely been recrystallized. Ostracods and benthonic foraminifers are much less in number. The micrite matrix has been slightly recrystallized.

The distribution of the three above mentioned standard microfacies types in the Felsőörs section is shown in Figure M-3.

The microfacies types of Aszófő (Farkó-kő) sections (Figure S-5) can be categorized into three main groups.

Group 1: microfacies types of basinal facies:

Filamentous bivalve micrite, wackestone (SMF–3) (Plate M-V, 4). Common. Filaments (thin planktonic bivalve shells) are abundant. Other bioclasts are represented by a few echinodermal and cephalopodal skeletal elements. In the majority of samples the micrite matrix has partly been recrystallized.

Spiculitic micrite, predominantly wackestone, rarely mudstone (SMF–1) (Plate M-V, 3). Abundant. Sponge spicules are the predominant biogenic grains. A few echinoderm and cephalopod skeletal elements may occur. The micrite matrix has partly been recrystallized.

Filamentous-spiculitic or spiculitic-filamentous micrite, mainly wackestone, rarely mudstone (SMF–3 or SMF–1) (Plate M-V, 5). Medium. It is the combination of the two aforementioned rock types. The micrite matrix has partly been recrystallized.

Spiculitic-foraminifer micrite, wackestone (SMF–1). Very rare. This microfacies type, though represented by one sample only, is worth mentioning because of the frequent occurrence of benthonic foraminiferal genus *Ophthalmidium* (?).

Spiculitic micrite with other bioclasts, wackestone or mudstone (SMF–1). Common. From among biogenic grains sponge spicules prevail, other bioclasts are of echinodermal, molluscan and/or brachiopodal origin. Their number is not very high but more than it is in the filamentous micrite and spiculitic micrite microfacies types. Similarly to the above microfacies types, the micrite matrix has partly been recrystallized.

Bioclastic micrite mudstone or rarely wackestone (SMF–3). Common. Bioclasts are made up mainly of echinoderm skeletal grains in a size of some hundred microns, rarely mollusc and/or brachiopod shell fragments and very rarely benthonic foraminifera. In the micrite matrix a lot of small rhombohedral carbonate crystals can be seen.

Slightly siliciclastic micrite, mudstone. Rare. Siliciclasts are represented by a few silt-sized quartz and muscovite grains. The micritic matrix has largely been recrystallized to microsparite.

Group 2: microfacies types originally deposited on a shallow submarine height or in/near platform margin environment, later redeposited in deeper local basins:

Bioclastic-peloidal/oncoidal micrite/sparite, packstone or grainstone (SMF–13) (Plate M-V, 6–8; Plate M-VI, 1–3). Medium frequency. The predominant part of the components are hardly identifiable, mainly fine-grained, more or less recrystallized micritic peloids. Nevertheless, in a few cases microbial coatings around nuclei of bioclast origin can be recognized indicating that these grains are oncoids. Bioclasts are fairly common. They are

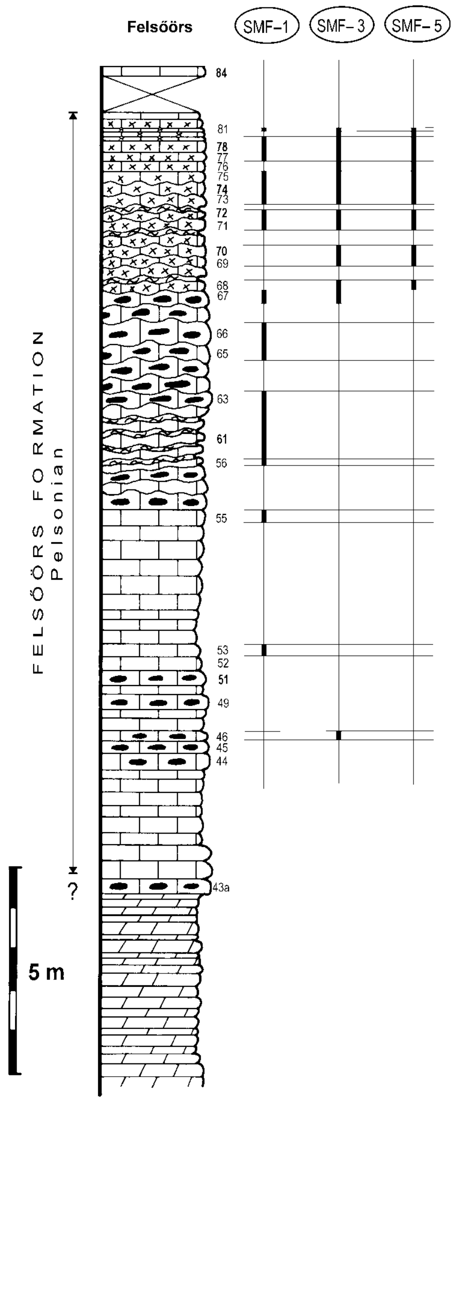

Figure M-3. Distribution of standard microfacies types (SMF) in the Pelsonian part of the Felsőörs section

SMF–1: spiculitic micrite, wackestone/packstone; SMF–3: filamentous micrite, wackestone; SMF–5: Bioclastic (crinoid–brachiopod–mollusc) micrite, packstone/wackestone. In the upper part of the section (beds 68–81) SMF–1 and SMF–3 (of deeper marine facies) serve as matrix of SMF–5 (redeposited from shallower environments). For legend see Figure S-3 represented by fragments of echinoderms, brachiopods and molluscs. Their size varies from a few millimetres to 1 or 2 centimetres. The interstitial material consists of micrite and mosaic sparite, or a combination of them. The sediments representing this microfacies-type were produced in shallow submarine environment and subsequently redeposited in the basin.

"Mixture" of bioclastic-peloidal/oncoidal packstone/grainstone and echinoderm micrite mudstone or scarcely filamentous micrite mudstone (SMF–13 + SMF–3) (Plate M-VI, 4, 5). Medium frequency. It was pointed out above that bioclastic (echinoderm) micrite mudstones are of basinal facies, whereas bioclastic-peloidal/oncoidal packstones/grainstones were produced in a shallow environment. On the basis of co-occurrence of these microfacies types one can conclude that the shallow water bioclastic-peloidal/oncoidal sediment mass or particles were carried down from their original depositional environment to the deeper local basins, where they redeposited and "mixed" with the basinal "embedding" sediment types.

Group 3: microfacies types affected by obliterative diagenetic recrystallization:

Generally finely crystalline, equigranular or inequigranular carbonates, whose original depositional texture is obliterated totally or nearly totally. Common. A few preserved echinoderm plates represent original components.

The microfacies of rocks exposed by Köveskál (Horog-hegy) section is *bioclastic packstone*, representing SMF–5 (Plate M-VI, 6–8). Main rock-forming components are the skeletal detritus of echinoids, crinoids, molluscs (including gastropods) and brachiopods. Subordinately a few ostracods and benthonic foraminifers and very rarely holothurian sclerites, phosphatic grains and *Globochaete* (?) also occur. Both thin and thick mollusc shells can be seen. Their original shell microstructure has completely been recrystallized, whereas brachiopod skeletal grains preserved their microstructure. The grain size of the majority of bioclasts is between 0.5 and 2 mm. No siliciclasts are present. The original micritic matrix has been recrystallized to microsparite or finely crystalline sparite.

Microfacies characteristics of rocks of Felsőörs Formation indicate various depositional environments. Rocks exhibiting SMF–1 and SMF–3 were deposited in a deep open basin (sensu WILSON 1975), in accordance with BUDAI (1993) and HAAS (1998), whereas rocks of SMF–5 deposited on slopes. One can conclude shallow water platform margin sedimentation from bioclastic-peloidal/oncoidal rocks displaying SMF–13. Masses or particles of this platform-derived material must have carried down at times to the deeper local basins (VÖRÖS *et al.* 1997) where they mixed with the basinal embedding sediments and formed the special "mixture" of SMF–13 and SMF–3.

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Plate M-I.

Photomicrographs illustrating microfacies types of the Tagyon Formation in the stratotype borehole Dörgicse Drt–1. Thin sections, plane polarized light.

1. Microoncoidal grainstone with a few benthonic foraminifers (arrows). Microoncoids are of various size. Small dolomite rhombohedra are common in the larger oncoids. Dörgicse Drt–1 borehole, 100.0 m
2. Dasycladacean grainstone/packstone. Abundant dasycladacean skeletal elements, partly recrystallized but well recognizable. The interstitial material is either micritic matrix or sparry calcite cement. Dörgicse Drt–1 borehole, 93.9 m
3. Vadolite. Vadoids are the main rock-forming components. Note characteristic graded bedding. Dörgicse Drt–1 borehole, 105.0 m, sample 11014.
4. Vadolite made up of vadoids of strikingly different grain size. Dörgicse Drt–1 borehole, 125.0 m, sample 11012.
5. Photomicrograph showing microfabric of vadoids. The nucleus of a vadoid can either be a normal or composite peloidal-micritic grain or, infrequently, a bioclast of algal origin (upper right margin of the picture). Note the more or less isopachous, but occasionally non-isopachous cortex that is thin compared to the size of the nucleus and the point contacts between the vadoids. Dörgicse Drt–1 borehole, 124.4 m, sample 11016.
6. Fenestral, peloidal microbial deposit with geopetal pore fillings in some of the fenestrae. Dörgicse Drt–1 borehole,105.0 m

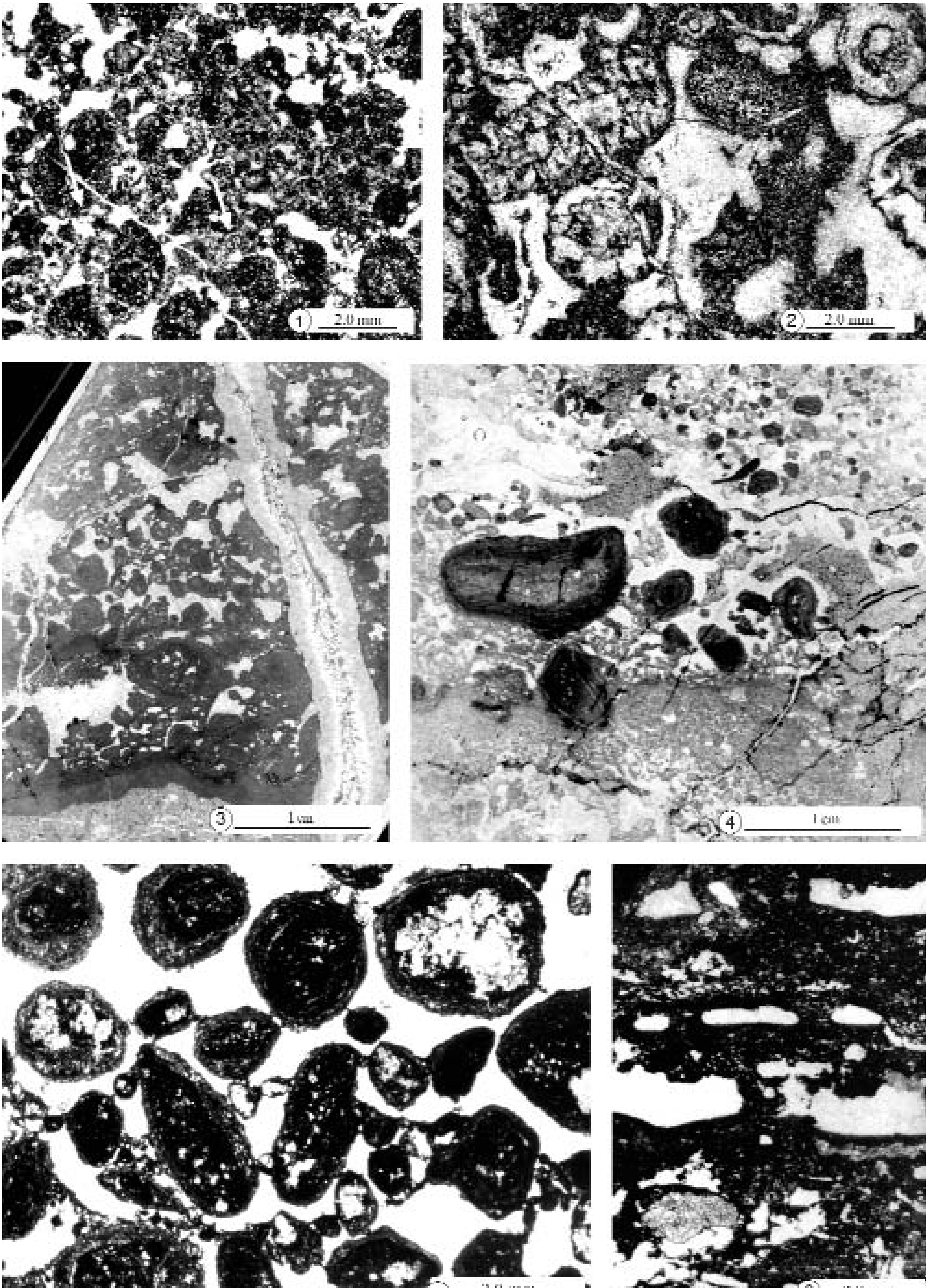
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Plate M-II.

Photomicrographs illustrating microfacies types of the Tagyon Formation from cores Dörgicse Drt–1 (1) and Szentantalfa Szaf–1 (2) and from the quarry at the military airport at Szentkirályszabadja (3–7). Thin sections, plane polarized light.

1. Brecciated calcrete (vadose carbonate crust). Dörgicse Drt–1 borehole, 88.2 m.
2. Micro/pisooncoidal grainstone. The majority of grains in this picture actually are pisooncoids. Szentantalfa Szaf–1 borehole, 88.2 m
3. Peloidal grainstone containing numerous vadose carbonate crusts, vadoids (bigger dark grains), a few molluscan shell fragments and two unbroken gastropods (arrows). Szentkirályszabadja, military airport, sample 40300.

4–5. Undetermined calcified cyanobacterial structure, a relatively frequent component of the Tagyon Formation at Szentkirályszabadja. Military airport, samples 1009 and 1008, respectively.

6. Dasycladacean skeletal elements contribute significantly to the construction of the Tagyon Formation at Szentkirályszabadja. Military airport, sample 1017.
7. Unbroken gastropods and mollusc shell fragments. Szentkirályszabadja, military airport, sample 40300.

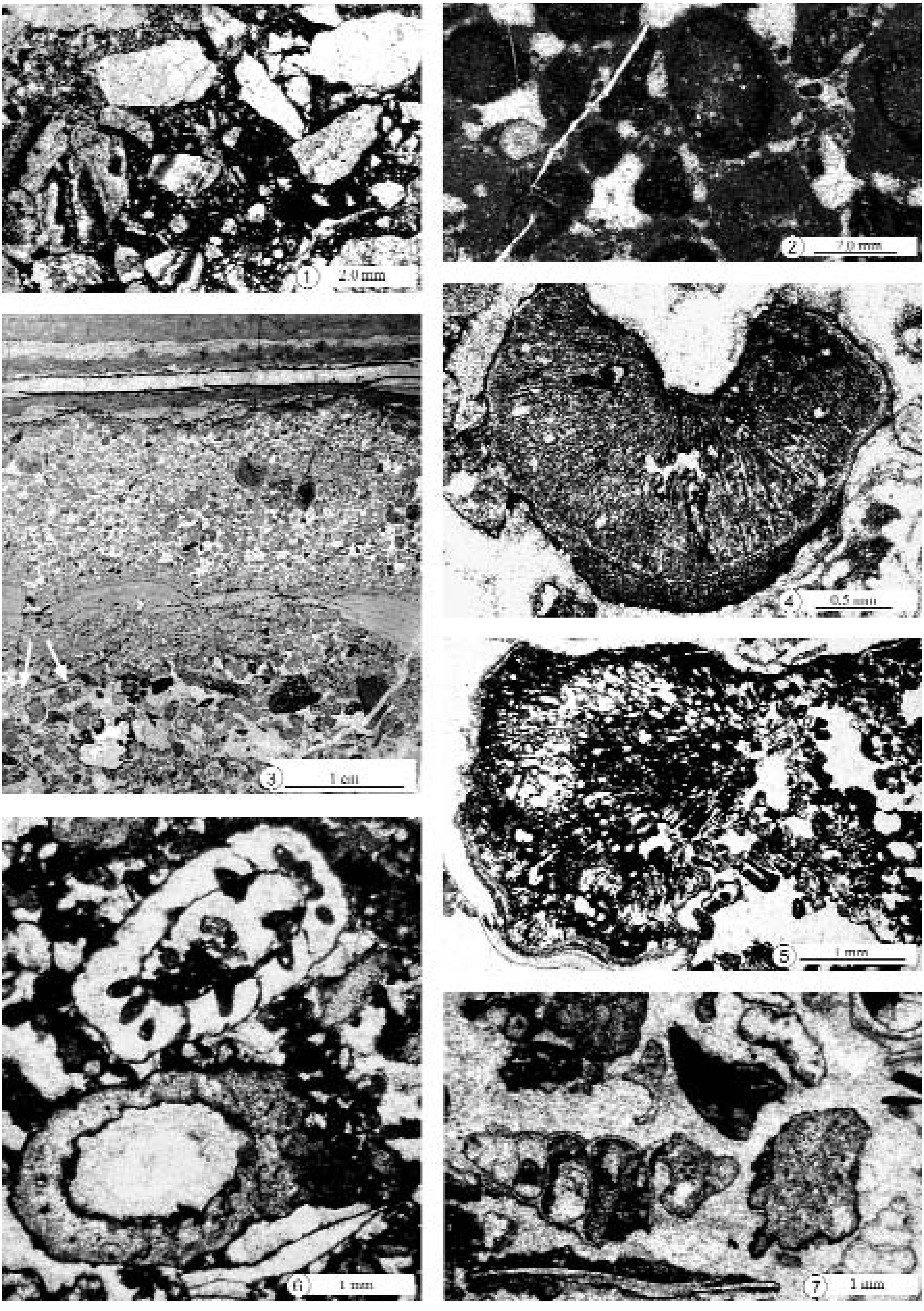
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Plate M-III.

Photomicrographs illustrating microfacies types of the Tagyon Formation from the military airport at Szentkirályszabadja. Thin sections, plane polarized light.

1. Detail of an unbroken ammonoid shell, a rare representative of cephalopods, in a molluscan oncosparite intercalation between two calcrete horizons. Note the microbial coating on the ammonoid shell. Szentkirályszabadja, military airport, sample 1002.

2–5. Vadoids showing various microfabrics.

2. Numerous vadoids of pisoid size in a fine grained sediment consisting of peloids, microoncoids and a few biogenic grains such as mollusc shell fragments, gastropods and echinoderms. Szentkirályszabadja, military airport, sample 1008;

3. Distorted vadoids with fine grained peloids and bioclasts (mollusc and dasycladacean skeletal fragments, gastropods and benthonic foraminifers) between them. Distortion of some of the vadoids might be caused by desiccation contraction. Szentkirályszabadja, military airport, sample 1007;

4. Vadoid (in the middle of the picture) displaying regular concentric lamination in a fine grained peloidal/microoncoidal sediment. Szentkirályszabadja, military airport, sample 21098;

5. Typical point contact between two grains exhibiting strikingly different microfabrics. Szentkirályszabadja, military airport, sample 21125.

6. Dasycladacean grainstone. A few of the abundant dasycladacean skeletal elements are distinctly visible whereas the majority of them has been recrystallized and display either faint ghosts or more frequently, grey spots. Dark, irregular spots are actually pores filled with reddish ferruginous microsparite and/or very finely crystalline sparite. In the lower middle part of the picture one gastropod can also be seen. Szentkirályszabadja, military airport, sample 40295.

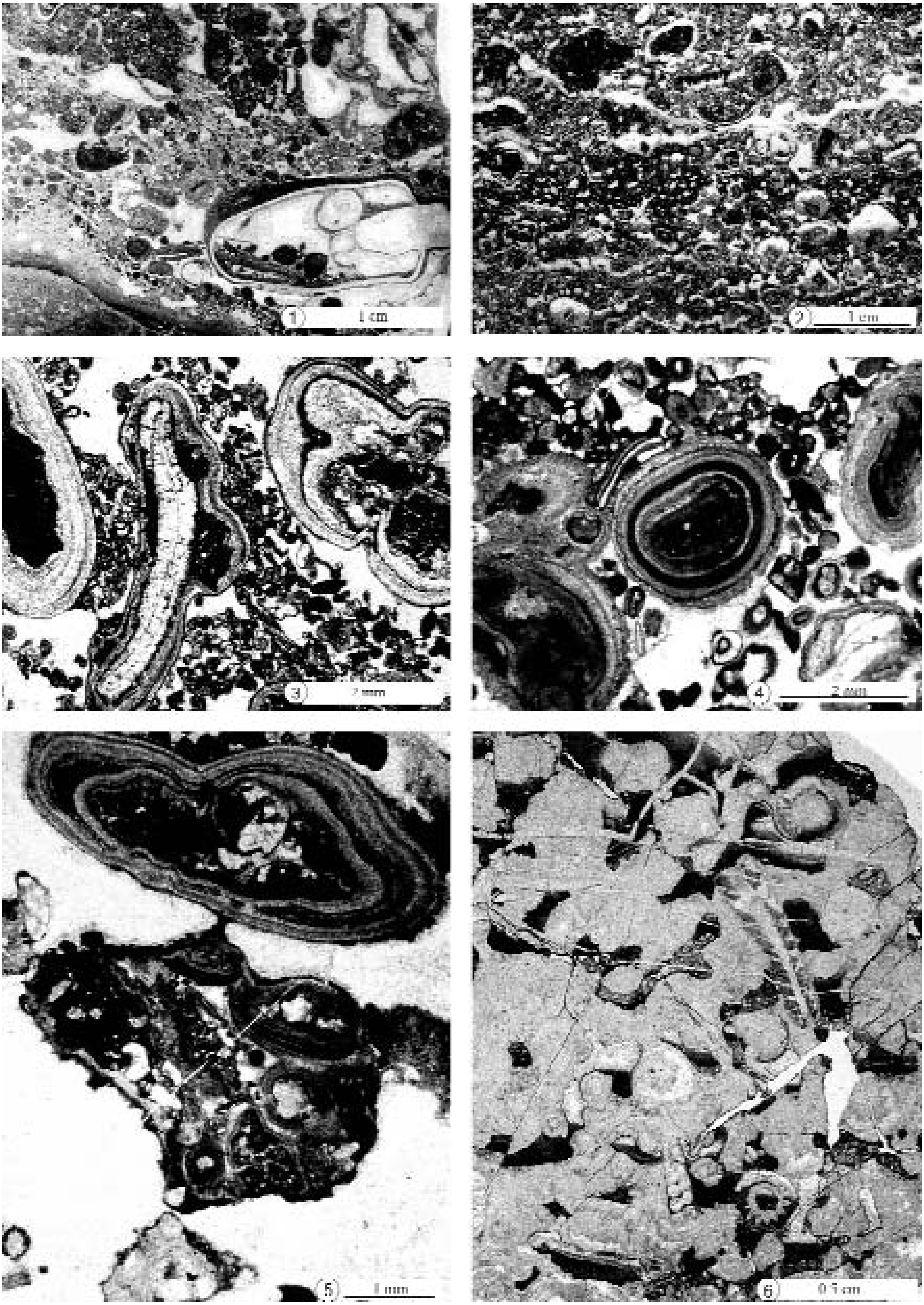
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Plate M-IV.

Photomicrographs illustrating microfacies types of the Tagyon Formation from Szentkirályszabadja and that of the Felsőörs Formation from Felsőörs, Forrás-hegy (= Malom-völgy). Thin sections, plane polarized light.

1. Fenestral microoncoidal grainstone with some vadose carbonate crusts and vadoids of microid/pisoid size. Szentkirályszabadja, military airport, sample 1012.
2. Microbial(?) stromatolite. In the lowermost part of the picture details of two iron-stained unidentified hemispheroids with pseudo-fibrous microfabric are visible, whereas the encrusting lighter carbonate crusts exhibit a festoon-like microfabric. The scattered tiny black spots above the hemispheroids are peloids and encrusting foraminifers. The irregular dark lenses among the light carbonate crusts consist of fine peloids. Szentkirályszabadja, military airport, sample 21097.
3. Spiculitic-bioclastic wackestone/packstone, SMF–1. Sponge spicules dominate over the fine detritus of echinoderms, molluscs and brachiopods. Note the silicification of the micritic matrix. Felsőörs, Bed 58, Forráshegy Member.
4. Echinoderm-mollusc-brachiopod packstone, SMF–5. Predominantly coarser bioclasts and a few microoncoids occur in micritic matrix. Felsőörs, Bed 76, Horoghegy Member.
5. Mollusc–brachiopod–echinoderm packstone, SMF–5. Note the relatively frequent unbroken gastropods and significant difference in the grain-size of the components. Felsőörs, Bed 76, Horoghegy Member.
6. Bioclastic (crinoid) packstone, SMF–5. Apart from the big half ossicle and the smaller crinoid particles the picture shows a completely recrystallized mollusc shell fragment in the middle of its left side. Felsőörs, Bed 69, Horoghegy Member.
7. Chalcedonic quartz replacement of some one third of the volume of a big crinoid plate, SMF–5. Felsőörs, Bed 73, Horoghegy Member.
8. Bioclastic (mollusc–crinoid–brachiopod) wackestone (SMF–5) with fragments of thin-shelled molluscs, a few crinoid skeletal elements and an oblique longitudinal section of a brachiopod (*Tetractinella* ?) shell showing foliated microstructure. Felsőörs, Bed 81, Horoghegy Member.

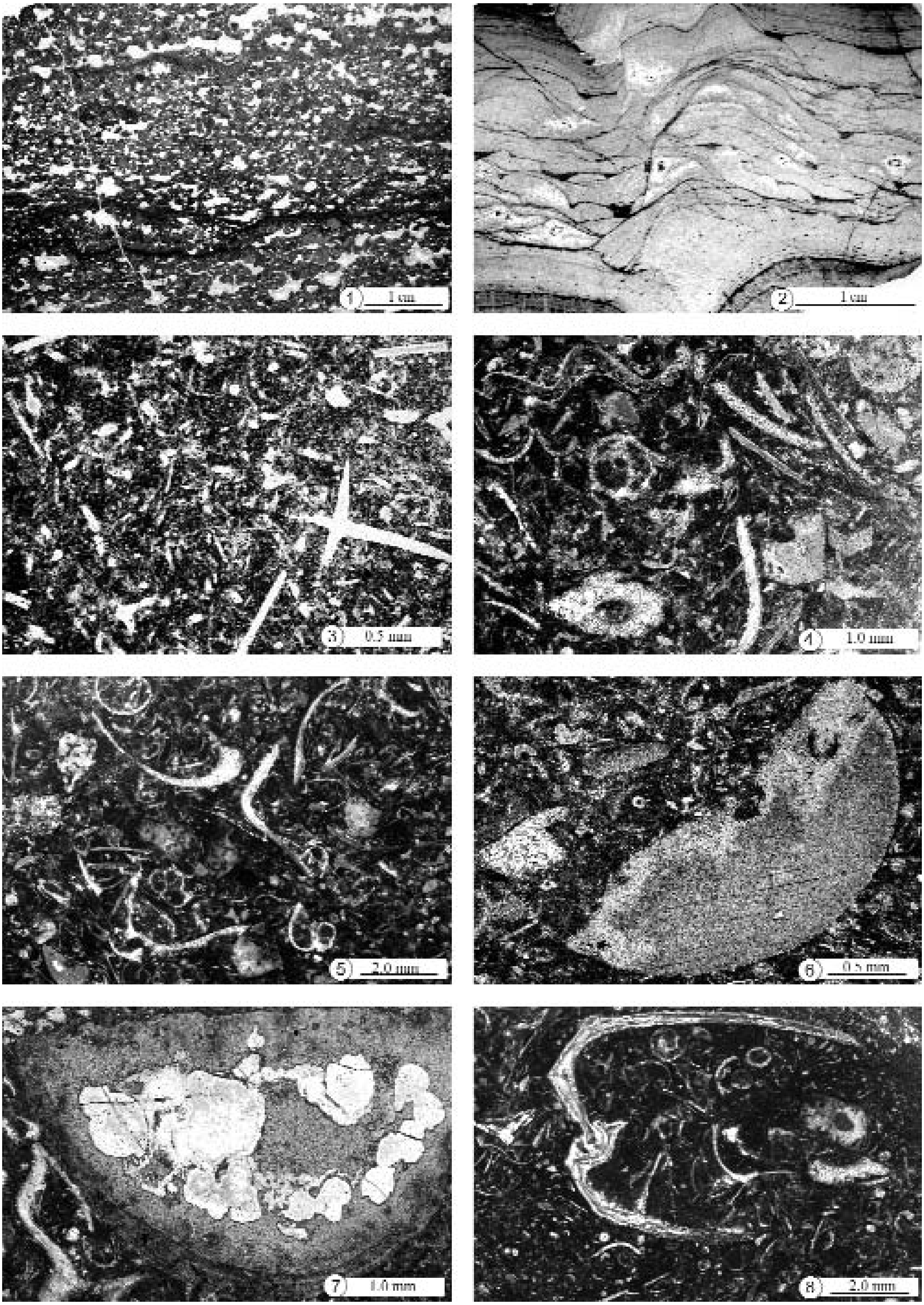
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Plate M-V.

Photomicrographs illustrating microfacies types of Felsőörs Formation from Felsőörs, Forrás-hegy and Aszófő, Farkó-kő. Thin sections, plane polarized light.

1. Bioclastic wackestone/packstone (SMF–5) with transverse section of an unbroken rhynchonellid brachiopod, a few echinoderm plates (lower right corner of the picture) and numerous thin mollusc shell fragments. Micritic material, mosaic sparite and silica fill the inner part of the brachiopod. Felsőörs, Bed 73, Horoghegy Member.
2. Bioclastic packstone, SMF–5. Bioclasts consist of numerous recrystallized mollusc shell fragments, less smaller echinoderm plates and a tooth. Micritic interstitial material. Felsőörs, Bed 69, Horoghegy Member.
3. Spiculitic micrite, wackestone, SMF–1. Sponge spicules of medium frequency. The original micritic matrix has been recrystallized to microsparite. Aszófő I, Bed 7, Bocsár Member.
4. Filamentous bivalve micrite, wackestone, SMF–3. Fragments of thin-shelled bivalves ("filaments") are abundant in the micritic matrix that has been recrystallized to microsparite. Aszófő II, Bed 6, Bocsár Member.
5. Filament wackestone with sponge spicules (SMF–3/SMF-1). Aszófő I, Bed 10, Bocsár Member, sample 34478.
6. Bioclastic-peloidal/microoncoidal grainstone (SMF–13) with echinoderm skeletal elements, mollusc shell fragments and one benthonic foraminifer (arrow). Aszófő II, Bed 23, Horoghegy Member.
7. Bioclastic-peloidal/microoncoidal grainstone, SMF–13. Bioclasts include big echinoderm (crinoid) plates and one fragment of a brachiopod. Aszófő II, Bed 16, Horoghegy Member.
8. Bioclastic-peloidal/microoncoidal packstone, SMF–13. Bioclasts are represented mainly by coarse crinoid ossicles and mollusc and brachiopod skeletal elements. Aszófő II, Bed 18, Horoghegy Member, sample 21117.

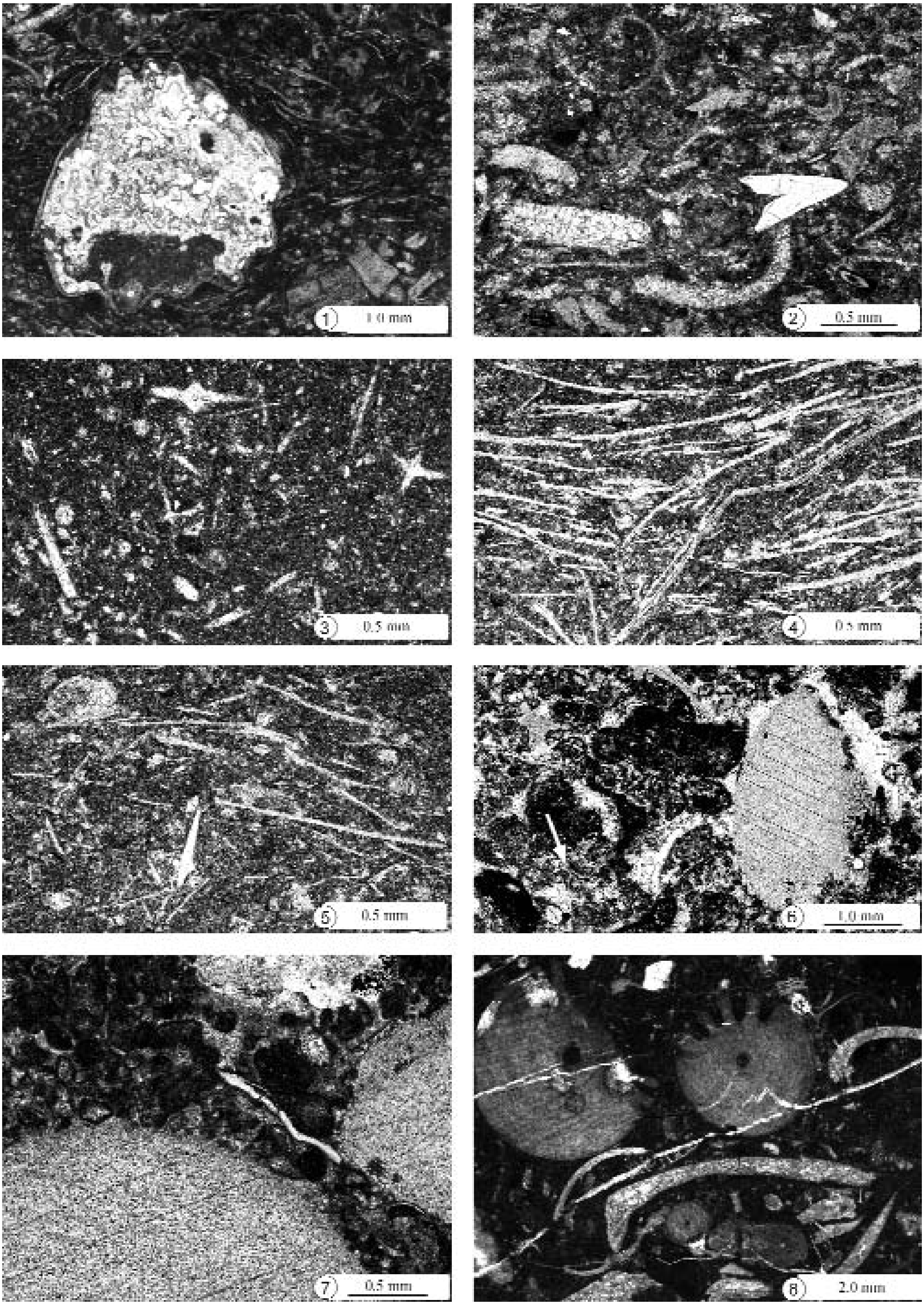
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Plate M-VI.

Photomicrographs illustrating microfacies types of Felsőörs Formation from Aszófő, Farkó-kő and Köveskál, Horoghegy. Thin sections, plane polarized light.

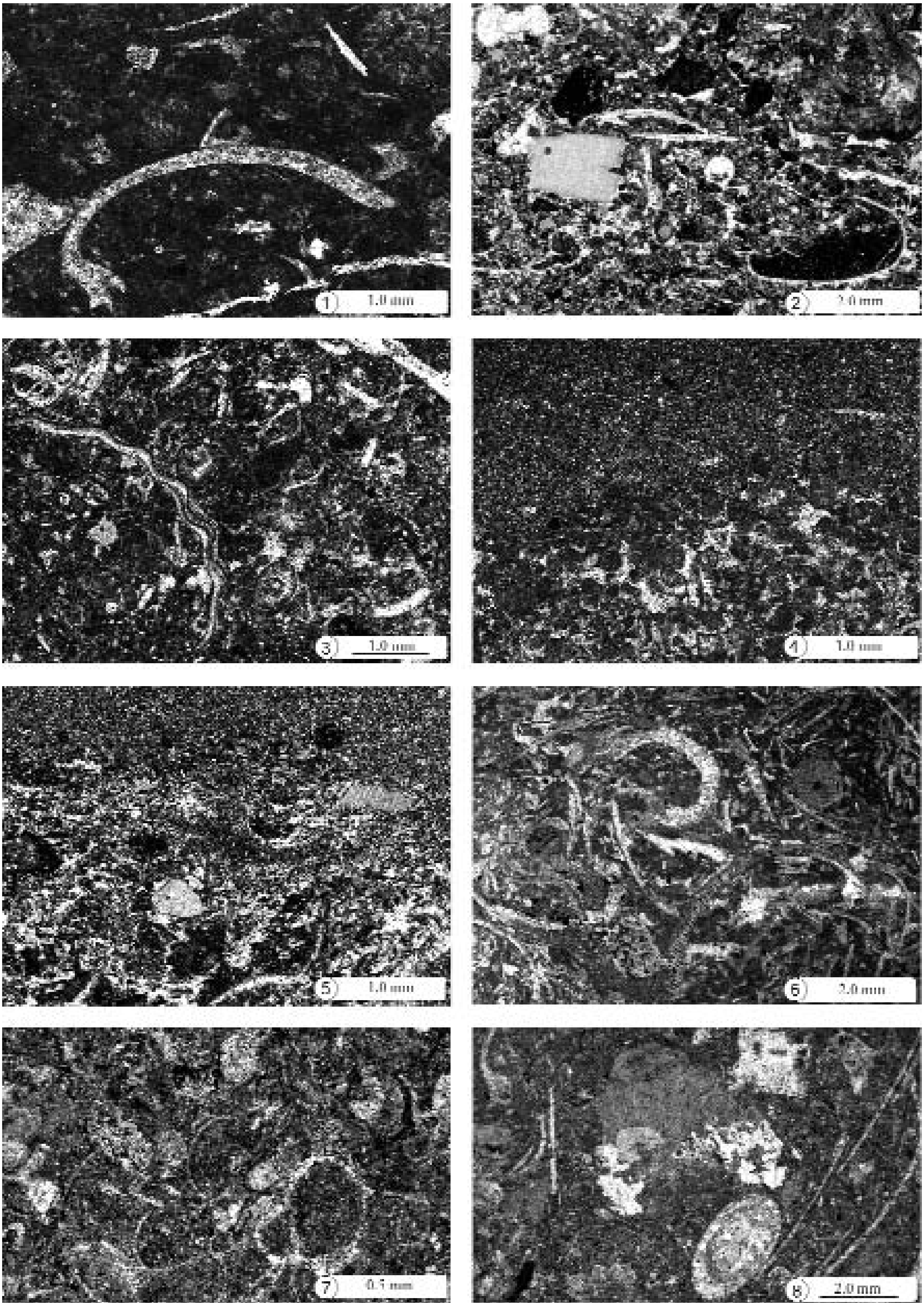
1. Bioclastic-peloidal/microoncoidal packstone, SMF–13. Note the big recrystallized bivalve shell, the scattered smaller echinoderm skeletal elements and the calcareous alga in the upper right corner of the picture. Aszófő II, Bed 18, Horoghegy Member, sample 21117.
2. Bioclastic (mollusc–crinoid)–peloidal/microoncoidal grainstone(?) (SMF–13) with a few pisooncoids (upper right corner) and one embryonic ammonoid shell (upper left corner). Aszófő II, Bed 31.
3. Bioclastic–peloidal/microoncoidal packstone, SMF–13. Bioclasts consist of mollusc, brachiopod and echinoderm skeletal elements. Aszófő II, Bed 17, Horoghegy Member.

4–5. "Mixture" of bioclastic–peloidal/oncoidal packstone/grainstone and echinoderm micrite mudstone or scarcely filamentous micrite mudstone (SMF–13 + SMF–3).

4. Detail of a microoncoidal grainstone lithoclast displaying SMF–13 (lower part of the picture) embedded in a very scarcely filamentous and echinoderm micrite mudstone, SMF–3 (upper part of the picture). Aszófő II,Bed 24, Horoghegy Member, sample 21118.

5. Lower part of the picture shows detail of a microoncoidal–echinoderm–mollusc grainstone lithoclast representing SMF–13, whereas in the upper part of the picture the embedding material (practically unfossiliferous micrite mudstone, SMF–3) can be seen. Aszófő II, Bed 23, Horoghegy Member.

6–8. Bioclastic packstone, SMF–5. The skeletal detritus of echinoids, crinoids, molluscs (including gastropods) and brachiopods are the main rock-forming components. Thin and thick mollusc shells have been completely recrystallized. Köveskál, Horog-hegy, Horoghegy Member, samples H–I/2, H–I/1 and H–IV, respectively.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