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First Evidence of Liassic in the Vicinity of Csővár (Hungary), and its Paleogeographic and Paleotectonic Significance

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With 3 Text-Figures

Ungarn
Budaer Berge
Radiolarien
Conodonten
Stratigraphie
Lias
Obertrias
Paläogeographie
Paläotektonik

Contents

Erster Nachweis von Lias in der Umgebung von Csővár (Ungarn) – Paläogeographische und paläotektonische Schlußfolgerungen

Zusammenfassung

Die Csővár Kalkstein-Formation sensu HAAS & KOVÁCS (1985) besteht aus zwei verschieden alten Einheiten von unterschiedlicher lithologischer Ausbildung. Die untere Einheit (Csővár Kalkstein-Formation sensu BALOGH, 1981, der diese Formation benannte) besteht aus dunklen, bituminösen, oft allodapischen und gradierten Kalken, Hornsteinkalken, mergeligen Kalken und Mergeln. In ihren Oberflächenaufschlüssen gehört diese Einheit zum Oberrhät, in Bohrungen tritt auch ein norischer Anteil auf.

Die obere Einheit besteht aus geschichteten, in einigen Teilen massiven, hellgelben bis hellbraunen, mikritischen Kalken und Hornsteinkalken. In ihrem oberen Teil führt sie mächtige Rutschmassen aus brekziösen Kalken. Der größte Teil der oberen Einheit, die hier als Várhegy Cherty Limestone Formation von der Csővár Kalkstein-Formation s.l. abgetrennt wird, gehört zum Hettangian. Der basale Teil der Einheit führt mit *Neohindeodella detrei* KOZUR & MOCK die jüngste Conodontenart der Welt, die wahrscheinlich das basale Hettangian charakterisiert. Der oberste Teil der Várhegy Cherty Limestone Formation gehört bereits zum Sinemurian.

Abstract

The Csővár Limestone Formation sensu HAAS & KOVÁCS (1985) consists of two units different in lithofacies and age. The lower unit (Csővár Limestone Formation sensu BALOGH, 1981, who established this formation) consists of dark, bituminous, often resedimented and graded limestones, cherty limestones, marly limestones and marls. The surface outcrops of the Csővár Limestone Formation belong to the Upper Rhaetian. In a borehole also Norian is present in the Csővár Limestone Formation.

The upper unit consists of bedded, in some parts massive, light-yellowish to light-brownish micritic limestones and cherty limestones. The upper part contains thick slump breccias. The upper unit is separated from the Csővár Limestone Formation s.l. and designated as Várhegy Cherty Limestone Formation. Its largest part belongs to the Hettangian. The basal Várhegy Cherty Limestone Formation has yielded *Neohindeodella detrei* KOZUR & MOCK, the stratigraphically youngest conodont species of the world that characterizes probably the basal Hettangian. The uppermost part of the Várhegy Cherty Limestone Formation belongs to the Sinemurian.

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1. Introduction

The Csővár area south of the Cserhát Mountains (geographic position see Text-Fig. 1) belongs to the geologically best investigated regions in Hungary. The most interesting outcrops are WNW of the Csővár village on the southern slope of the Vár-hegy (Castle Mountain) and in the southwards adjacent Kecskés-völgy (Goat Valley), formerly also named as Pokol-völgy (Hell Valley), a name that is still used by BALOGH (1981). The stratigraphic investigations began more than 130 years ago. SZABÓ (1860) placed the light-yellowish to light-brownish limestones from the southern slope and top of the Vár-hegy tentatively in the Liassic. He regarded these beds, in the present paper named as Várhegy Cherty Limestone Formation, as transitional beds between the dark, bituminous limestones, exposed in the Kecskés-völgy (by SZABÓ named as "Kalkmergelschiefer von Ördögmalom", Hungarian word for devils mill) and the light limestone from the Vás-hegy (Iron Mountain).

As shown below, the Várhegy Cherty Limestone Formation is really Liassic, but SZABÓ (1860, p. 43) concluded this age on the base of erroneous correlations with Upper Triassic shallow-water carbonates of the Pilis Mountains:

„ ... Liaskalk ? Den Namen Liaskalk lege ich ihm vorläufig bei wegen Ähnlichkeit der stratigraphischen Verhältnisse mit dem Kalkstein von Pilis auf dem entgegengesetzten Donauufer, in dem Prof. Peters einen Megalodus triqueter gefunden hat."

Neomegalodon triqueter was in this time used in broader sense than today for several different Carnian–Norian *Neomegalodon* species, but never for fossils of Liassic age (in the present sense).

According to VADÁSZ (1910) also STACHE regarded the limestones from Csővár as Jurassic. A somewhat different position was published by HAUER (1870). He regarded the light-coloured, partly cherty limestones of the Várhegy as Rhaetian Dachstein Limestone, whereas he placed the underlying really Rhaetian dark limestones and marls (Csővár Limestone Formation) in the Liassic. He referred for this age determination erroneously to SZABÓ (1860), who wrote, however, that these beds are situated below the Liassic limestones:

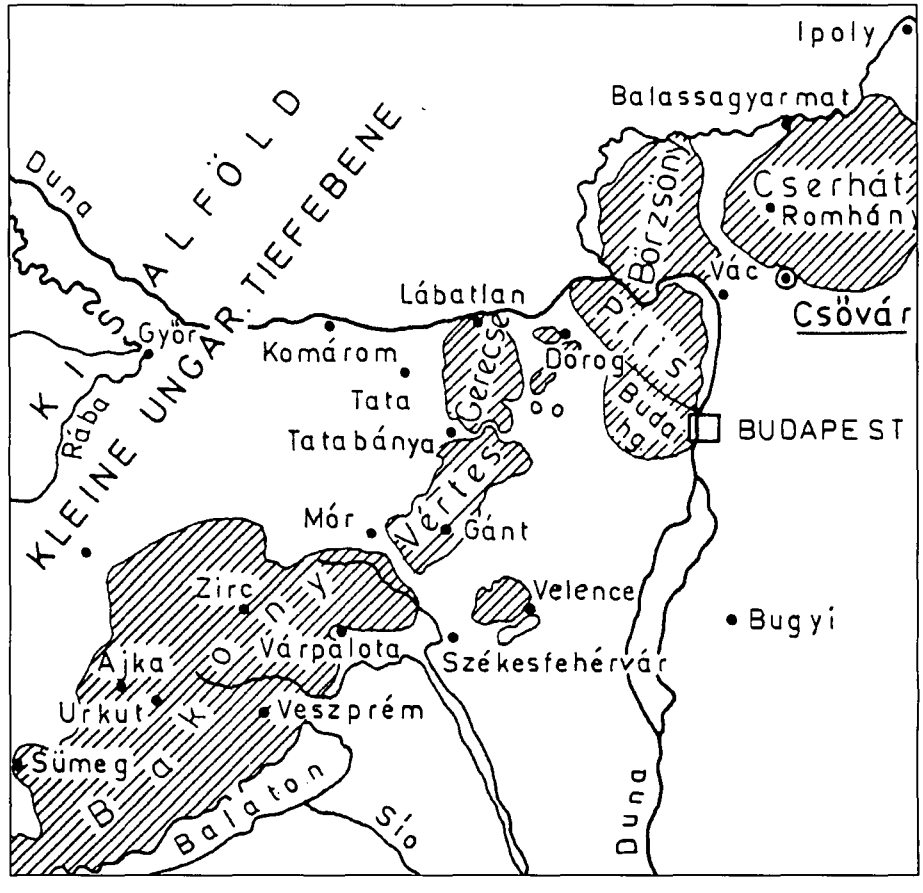
„ ... Brauner Mergelschiefer. Bei Csővár kommt ein beinahe marmorähnlicher Kalkmergelschiefer sehr gut geschichtet vor, der den Liaskalk von Csővár (Vashegy) unterteuft, mithin bildet er im aufgenommenen Terrain die tiefste secundäre Bildung ..." (SZABÓ, 1860, p. 43).

VADÁSZ (1910) placed the whole exposed limestone sequence of Csővár in the Lower Carnian, an age assignment that was for long time one of the central dogmas of the Hungarian Triassic stratigraphy. On the base of the correct lithostratigraphic correlation of the Csővár Limestone Formation s.str. with the Mátyashegy limestone of the Buda Mountains this dating was one of the most important stratigraphic data also for the Upper Triassic of the Buda Mountains. VADÁSZ (1910) was so sure about the Carnian age of the limestones on the southern slope of the Vár-hegy and from the Kecskés-völgy that he established even a *Phylloceras triassicum* for a Jurassic ammonoid. Until 1973 all Hungarian specialists placed the limestones of the Vár-hegy and the Kecskés-völgy in the Lower Carnian.

KOZUR & MOSTLER (1973) found in the dark, bituminous limestones of an abandoned large quarry in the Kecskés-völgy a rich conodont and holothurian fauna that they placed in the latest Triassic (Late Sevatian including Rhaetian). As DETRE et al. (1988, p. 53) pointed out, this age determination was in the beginning doubted by the Hungarian geologists, but finally adopted by DETRE (1981) and BALOGH (1981):

„ ... Az újdonság erejével hattotak H. KOZUR és H. MOSTLER (1973) Conodonta és Holothuroidea vizsgálatai, melyek eredményeként a csővári mészkövösszlet korát a legfelső-triászba (felső-nori-rhaeti) helyezték. A magyar szakközönség ezt a besorolást kezdetben bizalmatlanul fogadta, noha ...a csővári rög ilyen fiatal besorolása is logikus ..." (DETRE, C.S., 1981).

For several years, a contradiction between the micropaleontologic data that indicated latest Triassic age (KOZUR & MOSTLER, 1973), and the macropaleontological data that indicated Early Carnian age, continued. This the more, as an ammonoid sampled by KOZUR was again placed in the Carnian by ZAPFE and KRYSTYN (in KOZUR & MOSTLER, 1973). DETRE et al. (1988) solved this contradiction by the discovery of 6 specimens of *Choristoceras nobile* MOJSISOVICS, according to KRYSTYN (1987) probably a junior synonym of *Choristoceras ammonitiforme* (GÜMBEL). They placed this Late Rhaetian species in the Late Norian (Sevatian) using the data by KRYSTYN & WIEDMANN (1986). However,



Text-Fig. 1.
Geographic position of the Csővár area south of the Cserhát Mountains.
After TRUNKÓ (1969).

KRYSTYN (1987) has rejected his former view about the occurrence of the immediate forerunner of *Choristoceras* in the Middle Norian of Timor and he agrees now with the view of KOZUR (1972, 1973 and later papers) that *Choristoceras* is a Rhaetian index genus. He even excludes *Choristoceras haueri* from the genus *Choristoceras* s.str. that is according to these newer results of KRYSTYN (1987) a Late Rhaetian genus. The occurrence of *Choristoceras* forerunners in the Middle Norian of Timor seemingly indicate strong condension of these faunas, also indicated by conodont ranges different from uncondensed sections [e.g. restriction of *Mockina slovakensis* (KOZUR) to the Middle Norian, whereas this species in all well dated uncondensed sections is restricted to the Sevatian, see KOZUR, 1990].

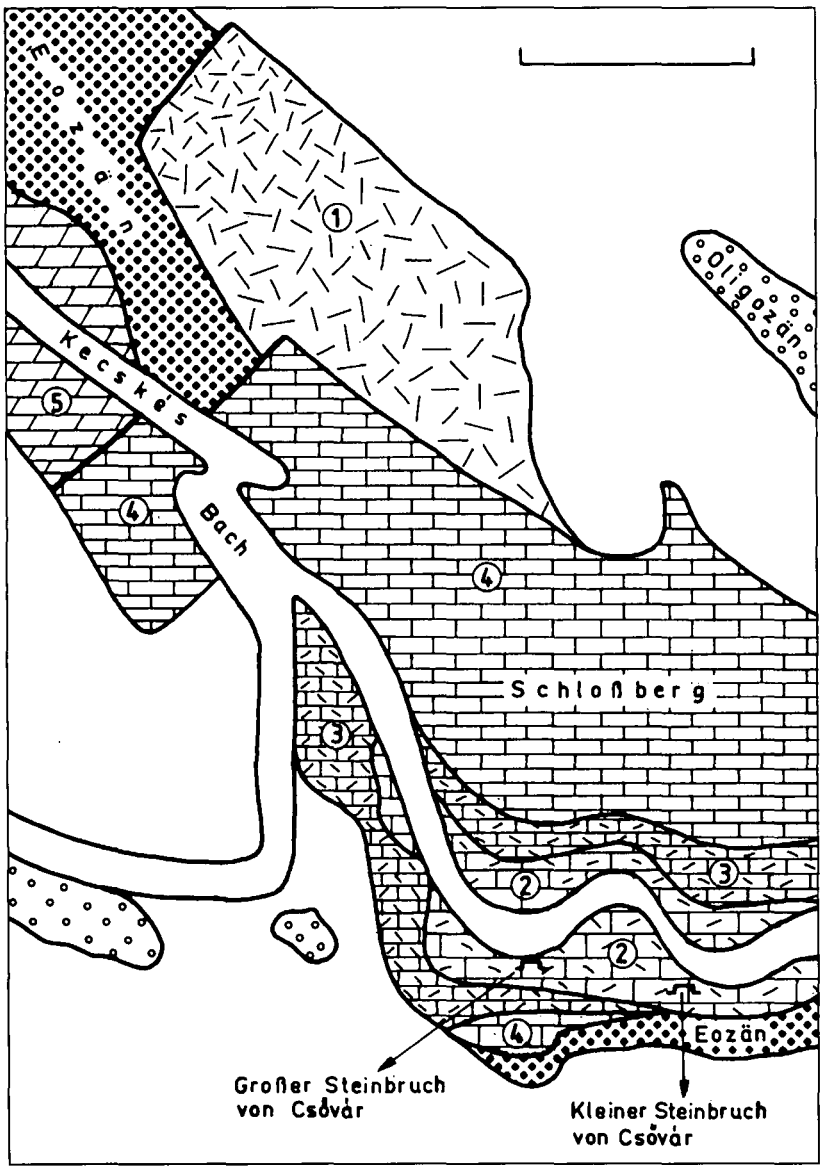
The results of KOZUR & MOSTLER (1973) and DETRE et al. (1988) demonstrate the big advantage of the micropaleontologic studies against the traditional ammonoid stratigraphy in the Triassic. For 78 years all macropaleontologic data have indicated Lower Carnian age for the Csővár Limestone Formation of its type locality and only DETRE et al. (1988) could demonstrate that these data were wrong. They confirmed the micropaleontologic data by KOZUR & MOSTLER (1973) that were achieved after few hours of sampling, some days of preparations and determinations.

HAAS & KOVÁCS (1985) placed the Csővár Limestone Formation s.str. (stratotype: the abondoned quarry in the Kecskés-völgy) and the light-coloured micritic limestones and cherty limestones (Várhegy Cherty Limestone Formation) in the Csővár Limestone Formation s.l. that they placed in the Carnian–Norian.

KOZUR & MOSTLER (1990) recognized for the first time Upper Hettangian radiolarians in the Várhegy Cherty Limestone Formation.

KOZUR & MOCK (1991) re-studied the type locality of the Csővár Limestone Formation. On the base of conodonts, they discriminated the *Misikella koessenensis* Subzone of the *M. posthernsteini* A.Z. and the *Misikella ultima* Zone in the typical sequence of the Csővár Limestone Formation s.str. This indicates a Late Rhaetian age for the Csővár Limestone Formation in its type locality. In the overlying Pre-*planorbis* Beds, they found for the first time conodonts, but only *Neohindeodella detrei* KOZUR & MOCK could be proven in these beds that have been placed in the latest Rhaetian or earliest Hettangian. KOZUR & MOCK (1991) found also for the first time conodonts in the basal Várhegy Cherty Limestone Formation that they assigned tentatively to the basal Liassic.

The Late Rhaetian age assignment of the type Csővár Limestone Formation is in agreement with the occurrence of *Choristoceras* s.str. in these beds (DETRE et al., 1988).



Text-Fig. 2.
Simplified geologic map of the area west of Csövár. Slightly modified after DETRE (1970).
1 = Dolomite of unknown age (not investigated); 2 = Csövár Limestone Formation and Pre-*planorbis* Beds (Upper Rhaetian, the Pre-*planorbis* Beds Upper Rhaetian to basal Hettangian); 3 = Basal Várhegy Cherty Limestone Formation: gray, bedded micritic limestones with *Neohindeodella detrei* KOZUR & MOCK (probably earliest Hettangian; 4 = Várhegy Cherty Limestone Formation: Thick-bedded or massive, light-coloured cherty limestones, in the upper part with slump breccias. Hettangian–Lower Sinemurian; 5 = Limestone and dolomites of unknown age (not investigated).
Scale = 500 m.

2. Geological Setting

DETRE (1970) mapped the Csővár area and he distinguished the following 4 pre-Tertiary units (see Text-Fig. 2):

① Ladinian (?) dolomite.
② Lower Carnian dark, bituminous, thick-bedded limestones, thin- bedded marls.
③ Lower Carnian gray, thin-bedded, less bituminous limestones, marls.
④ Carnian light, yellowish, partly cherty limestones.

The above age determinations were in agreement with the prevailing view among the Hungarian geologists.

KOZUR & MOSTLER (1973) investigated only the second above unit and placed it into the latest Triassic. As mentioned above (chapter 1.) this age determination

was confirmed by DETRE et al. (1988) by the discovery of *Choristoceras* s.str. of the *Ch. ammonitiforme* group.

BALOGH (1981) introduced the Upper Triassic Csővár Limestone Formation for the dark, bituminous limestones and marls, best exposed in an abandoned big quarry in the Kecskés-völgy, south of the Vár-hegy (see Text-Fig. 2). He included in this formation also similar rocks of Norian age drilled in a borehole in the Kecskés-völgy.

KOZUR & MOCK (1991) re-studied the above mentioned unit 2 (Csővár Limestone Formation s. str.) in the abandoned quarry and established for the first time a Late Rhaetian age for the stratoype of the Csővár Limestone Formation. The unit 3 of DETRE (1971), consisting of silty, partly sandy, dark marls and marly limestones and overlying gray, bedded micritic limestones, was also investigated by KOZUR & MOCK (1991). Surprisingly, also in these beds conodonts have been found (only *Neohindeodella detrei* KOZUR & MOCK). The lower part of this unit 3 corresponds lithofacially to the Pre-*planorbis* Beds of the Alps (see below). Its age is discussed in chapter 3. The upper part of the unit 3 changes gradually into the overlying light-coloured micritic, partly cherty limestones. It is here placed in the basal Várhegy Cherty Limestone Formation (age see chapter 3.).

The lithostratigraphic and biofacial character of the unit 2 from the abandoned quarry (Csővár Limestone Formation s.str.) were described by KOZUR & MOSTLER (1973). Most characteristic for this basinal pelagic sequence is the input of shallow-water material from adjacent reefs and carbonate platforms. In the uppermost exposed beds of the quarry, the lithofacial character changed abruptly. These beds have not been investigated by KOZUR & MOSTLER (1973), because the lithofacies (silty-sandy marls, marly limestones with plant detritus) is not suitable for conodonts and other microfossils. Lithofacially similar beds are known from the Alps, where a similar rapid facies change against the underlying Rhaetian beds can be observed. In the Alps these beds are generally named as Pre-*planorbis* Beds. Very few conodonts (*Neohindeodella detrei* KOZUR & MOCK) have been found in these beds by KOZUR & MOCK (1991).

Above the quarry, the Pre-*planorbis* Beds are replaced by gray, bedded, micritic limestones (upper part of unit 3 sensu DETRE, 1970). They are also exposed in the lower part of the southern slope of the Vár-hegy. These beds, situated with stratigraphic contact above the Pre-*planorbis* Beds and considerably above the last occurrence of *Choristoceras*, contain rather abundant conodonts, but only *Neohindeodella detrei* KOZUR & MOCK has been found. Also holothurian sclerites and radiolarians are present. These limestones contain no shallow-water clasts and are therefore lithofacially rather different from the Csővár Limestone Formation.

Without major facies change, these gray, micritic limestones become lighter (yellowish to light-brownish) and partly cherty. These light-coloured limestones (unit 4 sensu DETRE, 1970) built up an about 80 m thick sequence on the southern slope and top of the Vár-hegy. They are also present in the forest above the old quarry, immediately below the overlying Eocene conglomerate. These light-coloured limestones are bedded, but especially in the middle part also massive; in the upper part big bodies of slump breccias are present. These light-coloured, micritic, partly cherty pelagic limestones without clasts of shallow-water components are here designated as Várhegy Cherty Limestone Formation. The above mentioned gray, bedded, micritic limestones above the Pre-*planorbis* Beds are regarded as the lower member of the Várhegy Cherty Limestone Formation.

The Várhegy Cherty Limestone Formation is rich in microfossils, especially radiolarians are common. Their preservation (with exception of the saturnalids) is, however, mostly bad. As mentioned above, the conodont *Neohindeodella detrei* KOZUR & MOCK is common in the lower member of the Várhegy Cherty Limestone Formation. Macrofossils are present throughout the entire formation, but rather rare. Several ammonoids have been found, but only floated specimens. Brachiopods occur in the lower member.

3. Age of the Várhegy Cherty Limestone Formation

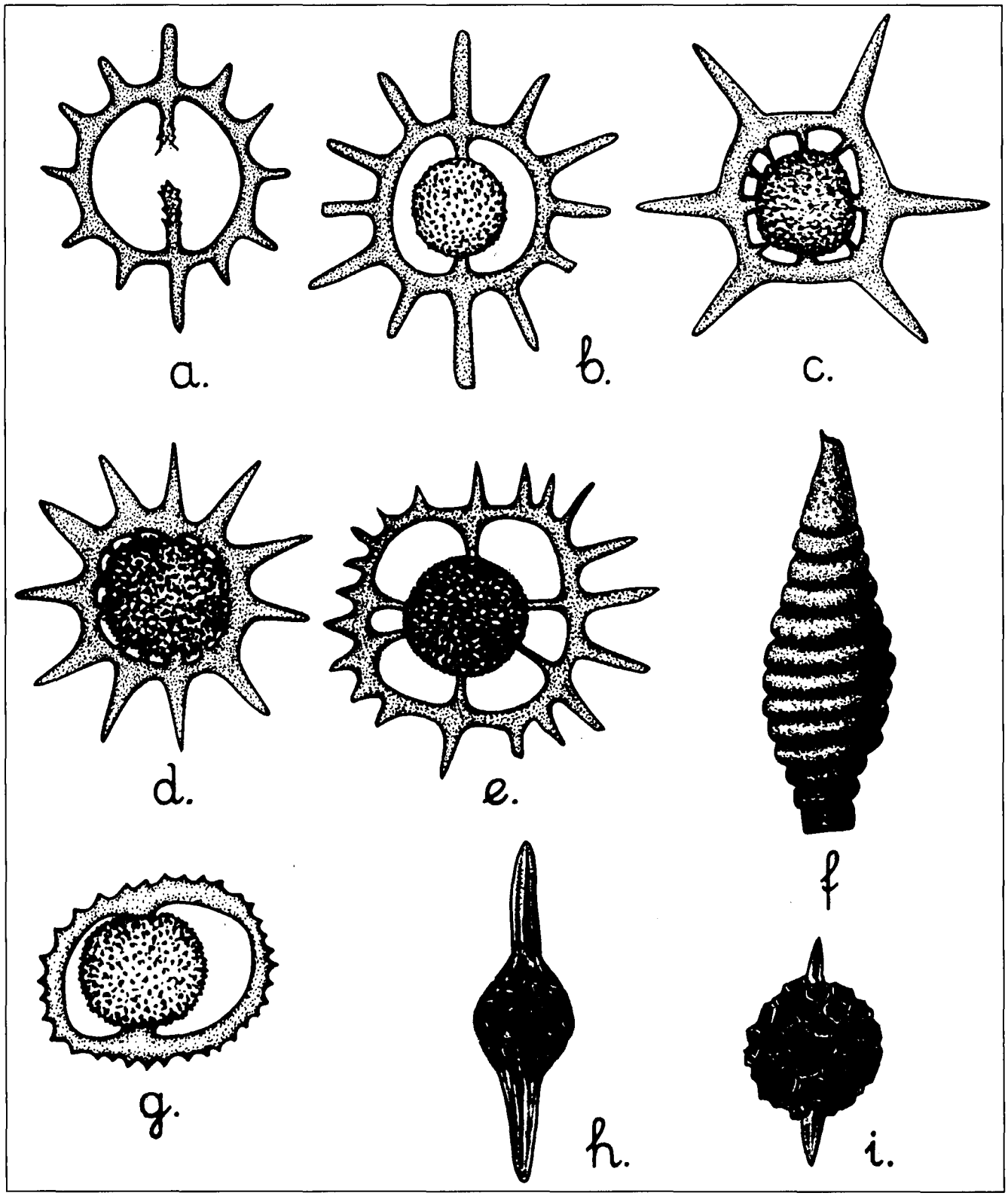
As mentioned above and in the historical review of the investigations in the chapter 1., the light-coloured limestones from the Vár-hegy near Csővár, the type locality of the Várhegy Cherty Limestone Formation designated in the present paper, have been placed since VADÁSZ (1910) by all Hungarian specialists in the Lower Carnian. After the discovery of latest Triassic conodonts in the underlying Csővár Limestone Formation by KOZUR & MOSTLER (1973), a post-Triassic age of these beds had to be expected.

However, HAAS & KOVÁCS (1985) placed these beds as part of their Csővár Limestone Formation s.l. in the Norian, after a long time-gap overlain by Eocene rocks. These results, based on micropaleontological investigations by KOVÁCS, were so surprising that I have investigated and sampled the Várhegy section once more. Later, during an excursion with students and colleagues from the Innsbruck University, further samples have been taken. We could not find any tectonic complications that could explain the occurrence of Norian rocks above the Upper Rhaetian rocks of the Csővár Limestone Formation s.str. The lower member of the Várhegy Cherty Limestone Formation, exposed above the old quarry in the Kecskés-völgy, is also well exposed on the lower slope of the Vár-hegy. In both cases, these beds are gradually overlain by light-coloured, partly cherty limestones.

Unfortunately, HAAS & KOVÁCS (1985) have not given data for their age determinations. However, DETRE et al. (1988) published some data of KOVÁCS. They reported the presence of *"Gondolella" steinbergensis* (MOSTLER) determined by KOVÁCS. *Norigondolella steinbergensis* (MOSHER), however, is not restricted to the Norian.

KOZUR & MOCK (1991) confirmed the occurrence of this species in the lower part of the old quarry. According to these authors, *N. steinbergensis* occurs in pelagic limestones with low clay content from the Middle Norian up to the lower part of the Upper Rhaetian. According to KRYSTYN (1987), this species is especially frequent in the Lower Rhaetian. *N. steinbergensis* cannot be used as evidence for Norian age of the upper Csővár Limestone Formation.

The light-coloured limestones of the Várhegy Cherty Limestone Formation are still considerably younger than the Csővár Limestone Formation, separated from it by the Pre-*planorbis* Beds and by the lower member of the Várhegy Cherty Limestone Formation. The assignment of these light-coloured limestones as part of the Csővár Limestone Formation to the Norian by HAAS & KOVÁCS (1985) is hardly understandable. Radiolarians from these beds were given by KOVÁCS to L. DOSTÁLY, Budapest. SEM photos of these



Text-Fig. 3.
Upper Hettangian radiolarians from the upper Várhegy Cherty Limestone Formation of the type locality.
a = *Palaeosaturnalis schaafi* KOZUR & MOSTLER, x 200; b = *Palaeosaturnalis liassicus* KOZUR & MOSTLER, x 200; c = *Praehexasaturnalis kirchsteinensis* KOZUR & MOSTLER, x 250; d = *Pseudoheliodiscus alpinus* KOZUR & MOSTLER, x 200; e = *Staurosaturnalis asymmetricus* KOZUR & MOSTLER, x 200; f = *Relanus hettangicus* KOZUR & MOSTLER, drawing combined from different specimens of rather bad preservation, x 300; g = *Spinoellipsella densispinosa* KOZUR & MOSTLER, x 300; h = *Ellipsoxiphus suessi* (DUNIKOWSKI), x 300; i = *Ellipsoxiphus tanuensis* (PESSAGNO & BLOME), x 350.

radiolarians have shown the same radiolarian faunas that we have published from this section (KOZUR & MOSTLER, 1990, KOZUR, MOCK & MOSTLER, in press). DOSTÁLY agrees with the Liassic age of these faunas. May be, that KOVÁCS, not familiar with radiolarian taxonomy and stratigraphy, has misinterpreted the common occurrence of *Mesosaturnalis* KOZUR & MOSTLER, from the lower and middle Várhegy Cherty Limestone Formation as evidence for Norian age,

because the type species of *Mesosaturnalis*, *M. levis* (DONOFRIO & MOSTLER), has derived from the Norian. However, this genus is most frequent in the Rhaetian and Lower Hettangian.

As mentioned above, the lower member of the Várhegy Cherty Limestone Formation contains *Neohindeodella detrei* KOZUR & MOCK. The radiolarian fauna of these beds consists mainly of new species of *Mesosaturnalis* KOZUR & MOSTLER and *Saturnosphaera* TICHOMIROVA.

Immediately above the last occurrence of *N. detrei* the first *Relanus hettangicus* was found. This species is a Hettangian guideform, surely not present in the Rhaetian. Its lower range within the Hettangian, however, is unknown. This species is very characteristic for the Upper Hettangian radiolarian fauna of Lenggries, Bavaria (KOZUR & MOSTLER, 1990) and the guideform of the Hettangian *R. hettangicus* Zone. Most probably, it is not yet present in the lower third of the Hettangian. Rhaetian guideforms or species and genera that ranges up to the top of the Rhaetian, as the frequent and very characteristic genus *Livarella* KOZUR & MOSTLER, are absent in the radiolarian fauna of the lower member of the Várhegy Cherty Limestone Formation. Also the monotonous holothurian fauna, consisting mainly of *Theelia*, does not contain any Rhaetian or Norian–Rhaetian guideform. On the other hand, some Hettangian radiolarian genera, unknown from the Rhaetian, are present in this fauna. The rather bad preservation does not allow a specific determination, but some of them may be conspecific with new Upper Hettangian species of Lenggries (KOZUR & MOSTLER, in press). All Upper Hettangian guideforms are, however, missing. Moreover, *Mesosaturnalis*, dominating in the lower and middle Várhegy Cherty Limestone Formation, is missing in the Upper Hettangian.

Despite the presence of the conodont species *N. detrei* KOZUR & MOCK, the lower member of the Várhegy Cherty Limestone Formation is regarded as Lower Hettangian. Therefore the basal Várhegy Cherty Limestone Formation contains the only known Liassic conodonts. Reworking of these conodonts from underlying beds can be excluded. In the immediately underlying Pre-*planorbis* Beds, *N. detrei* is extraordinarily rare. Only 2 specimens have been found in these beds. Reworking from the Rhaetian *Misikella ultima* Zone or still older zones can be excluded, because no Rhaetian guideforms (*Misikella* species) have been found in the Pre-*planorbis* Beds and in the overlying lower member of the Várhegy Cherty Limestone Formation. *Neohindeodella detrei* is a very fragile, rather large, but very thin form. Reworking of such forms is only possible by reworking of rock particles. But the lower Várhegy Cherty Limestone Formation does not contain any reworked clasts.

The lower part of the light-coloured limstones and cherty limestones contains a very similar radiolarian fauna as the conodont-bearing lower member of the Várhegy Cherty Limestone Formation. *Mesosaturnalis* KOZUR & MOSTLER dominates also in these beds. This excludes Late Hettangian age. Only few additional forms, like *Relanus hettangicus* KOZUR & MOSTLER, are present. Typical large quadratic to rectangular Upper Hettangian *Stauracanthocircus* species are still missing. This radiolarian fauna is undoubtedly Hettangian, but older than the Upper Hettangian radiolarian fauna of Lenggries.

The above radiolarian data suggest an Early Hettangian age for the lower half of the Várhegy Cherty Limestone Formation. The Upper Várhegy Cherty Limestone Formation contains a radiolarian fauna that is not so rich and well-preserved as the Upper Hettangian Lenggries radiolarian fauna, but all determinable species are conspecific with this fauna. Like in Lenggries, *Mesosaturnalis* is missing and the characteristic quadratic or rectangular *Stauracanthocircus* species of the Lenggries fauna are present. This radiolarian fauna is undoubtedly of Late Hettangian age.

Two samples from the top of the Várhegy have yielded a radiolarian fauna that contains several species of the Upper Hettangian Lenggries radiolarian fauna. However, beside these species several new species occur that are transitional between the Upper Hettangian radiolarian faunas of Lenggries and the Pliensbachian radiolarian faunas of southwestern Turkey. This fauna is placed in the Sinemurian.

So far, all well to moderately preserved radiolarians of the Várhegy Cherty Limestone Formation belong to the Saturnaliacea. Nassellaria are present as well, but mostly badly preserved. Only some Nassellaria species, like *Relanus hettangicus* KOZUR & MOSTLER and some new species (KOZUR & MOSTLER, in press) can be determined in this preservation. Therefore not all samples can be well dated. Above the characteristic Lower Hettangian fauna with *Relanus hettangicus* and abundant *Mesosaturnalis* spp., often only a Late Hettangian to Sinemurian age can be determined. Moreover, the investigation of the slump breccias is now in progress. The matrix and the blocks will be investigated separately to recognize, wheather they are synchroneous or of different age.

4. Paleogeographic and Paleotectonic Consequences of the New Stratigraphic Data from the Csővár Area and Critical Remarks to Some New Paleogeographic and Paleotectonic Concepts

The Hettangian age of the Várhegy Cherty Limestone Formation and the discovery of pelagic Jurassic limestones with *Podobursa* in a tectonic sliver with breccias of Sevatian, Rhaetian and few Jurassic limestones below Lower Norian pelagic cherty dolomites from the Mátyáshegy quarry in the Buda Mountains are important for the paleogeographic reconstruction of the Lower Liassic, because Jurassic rocks were so far unknown from the area SE of the Buda Line and of different facies in the area NW of the Buda Line. However, the main significance of these discoveries lies in the fact that these rocks have been placed by HAAS & KOVÁCS (1985) in the Lower Carnian (for the Upper Sevatian to Rhaetian Mátyáshegy Limestone of the Buda Mountains, including also the Jurassic rocks near the thrust plane) or in the Norian (for the Várhegy Cherty Limestone Formation). This "Lower Carnian" and "Norian" were then the base for the Upper Triassic palinspastic reconstructions by KOVÁCS (1982 and later papers). These reconstructions, in turn, are the base of the paleotectonic reconstructions by KOVÁCS for the Alpine-Carpathian realm. Without careful consideration of the pre-Triassic and post-Triassic development, these erroneous Triassic reconstructions, based on fundamental misinterpretations of the age of decisive important Triassic sequences, were then interpolated into other ages. So, the Middle Carboniferous reconstruction of KOVÁS in EBNER et al. (1991) is exactly his Triassic reconstruction with indicated Carboniferous occurrences. In this reconstruction the Miocene Carpathian arc is already present in the

Middle Carboniferous, like the configuration of the Jurassic Vardar ocean. For the Gemeride Paleozoic "post-varistische Frühmolasse" (post-Hercynian early molasse) is indicated. Early molasse stage of the Hercynian cycle in the Middle Carboniferous is impossible, because early Hercynian molasse, known in Middle Europe, is of Viséan age. Post-Hercynian would mean that this molasse is not more related to the Hercynian cycle, but to the following Cimmerian cycle. Early molasse of this post-Hercynian cycle has, however, Liassic age, well known from Turkey and Iran.

It is clear that the recent distribution of Upper Triassic facies belts cannot fit into a model, elaborated on Upper Triassic sequences in Hungary, where the key sections (e.g. Csővár area, Buda Mountains) are stratigraphically and tectonically misinterpreted as shown in the present paper and by KOZUR & MOCK (1991). Instead to check the stratigraphic and tectonic basic data, the present-day distribution of the facies belts has been changed or hypothetical positions of Upper Triassic facies boundaries have been constructed that do not exist in the indicated place. For instance, according to KÁZMÉR & KOVÁCS (1985) the western boundary of the Hallstatt Limestone Belt is situated in the Northern Calcareous Alps in the meridian of Graz, about 200 km east of the Hallstatt Limestone type area. This change of the present distribution of the facies belts was necessary to fit them in the Triassic palinspastic reconstruction, based on numerous stratigraphic misinterpretations of Triassic key-sections in Hungary.

For instance, the Mátyáshegy Limestone of the Buda Mountains was placed in the Lower Carnian by HAAS & KOVÁCS (1985) and the Cherty Dolomite of the Buda Mountains was placed in the Lower to Middle Carnian. On this base, both the Upper Norian–Rhaetian Mátyáshegy Limestone and the Lower to Upper Norian Cherty Dolomite (both pelagic deposits, rich in radiolarians and pelagic conodonts and belonging to two different nappes of the Buda Mountains SE of the Buda Line) were placed at the base of the Upper Triassic shallow-water sequence NW of the Buda Line (Main Dolomite/Dachstein Limestone) that belong to an other nappe of an other nappe system, attached only during Late Miocene strike-slipe movements along the Buda Line.

This "unified sequence" of the Buda Mountains that nowhere exists (the Cherty Limestone or Mátyáshegy deep-water deposits and the contemporaneous Main Dolomite/Dachstein Limestone shallow-water deposits exclude each other) was then correlated with the sequence of the Balaton Hochland that has, of course, nothing to do with the Triassic sequence SE of the Buda Line.

On the other hand, the former correct lithostratigraphic correlation of the Mátyáshegy Limestone with the Csővár Limestone Formation was rejected by HAAS & KOVÁCS (1985). Since VADÁSZ (1910) all Hungarian geologists have correlated these two lithostratigraphic units. By this, both units have been erroneously placed in the Early Carnian, according to the assumed age for the Csővár Limestone Formation. This was insofar very important, because by this correlation the similarity of these two areas both situated immediately SE of the Buda Line, and the differences of this sequences against the sequences NW of the Buda Line, could be well recognized, despite the fact, that a wrong, but equal age has been assumed for both the Mátyáshegy Limestone, cherty dolomite and the Csővár Limestone Formation.

Because of the scarcity of fossils in the Buda Mountains, the age of some units SE of the Buda Line was concluded by correct (!) lithostratigraphic correlations with units in the Csővár area. For this reason, all Hungarian geologists (e.g. BALOGH, 1981; WEIN, 1977) have recognized the extraordinary importance of the Csővár Mesozoic at least for the local stratigraphy of the Csővár area and Buda Mountains. Thus, BALOGH (1981, p. 31) wrote:

"... Since E. VADÁSZ (1910, 1911) up to most recent times almost everybody regarded the alternation of cherty limestones and gray marls in the Pokolvölgy quarry (remark: the big abandoned quarry of the Kecskés-völgy of the present paper) as the Archimedean point of the local Triassic stratigraphy. And since the afore mentioned sediments were even quite lately sought to be pushed down to the Carnian Stage (...), it was a great surprise to see H. KOZUR and H. MOSTLER (1973) conclude that the sediments in the afore mentioned quarry are not of Carnian, but of Upper Sevatian age ... "

HAAS & KOVÁCS (1985) accepted a Sevatian age of the upper Csővár Limestone Formation in the Kecskés-völgy (in reality Late Rhaetian, see chapter 3.), but they did not change the Early Carnian age determination of the Mátyáshegy Limestone of the Buda Mountains. However, the Early Carnian age of the Mátyáshegy Limestone was established since VADÁSZ (1910) by its correlation with the lithofacially identical upper Csővár Limestone Formation of the Kecskés-völgy. KOZUR & MOCK (1991) proved that the correlation of the Mátyáshegy Limestone with the Csővár Limestone Formation of the Kecskés-völgy by VADÁSZ (1910) and in later papers of Hungarian authors was correct, but the surface outcrops of both units have Rhaetian and not Early Carnian age. The Mátyáshegy Limestone of the Buda Mountains and the Csővár Limestone Formation belong to the same formation of the same nappe immediately SE of the Buda Line (Csővár Nappe sensu KOZUR & MOCK, 1991).

Because HAAS & KOVÁCS (1985) placed the "Lower Carnian" Matyáshegy Limestone in the succession NW of the Buda Line with Norian Main Dolomite overlain by Norian-Rhaetian Dachstein Limestone, they could not find any difference between the totally different Triassic developments SE and NW of the Buda Line, but they found a total different Norian development between the Csővár area SE of the Buda Line (fully pelagic deep-water deposits) and that part of the Buda Mountains which is situated south of the Buda Line (assumed lagoonal or intertidal Norian deposits, but in reality fully pelagic Norian–Rhaetian, like in the Csővár area).

KOVÁCS re-investigated the Mátyáshegy Limestone and the Cherty Limestone of the Buda Mountains, but because of the preconception that the Mátyáshegy Limestone and the Cherty Dolomite of the Buda Mountains correspond to the Lower and Middle Carnian cherty limestones and cherty dolomites of the borehole Zsámbek, far NW of the Buda Line, the Mátyáshegy Limestone and the Cherty Dolomite of the Buda Mountains were furthermore placed in the Lower–Middle Carnian despite the fact that both the pelagic dark, bituminous, partly cherty Mátyáshegy Limestone and the pelagic cherty dolomite (Sashegy Dolomite Formation sensu BALOGH, 1981, secundarily dolomitized pelagic cherty limestone) contain a lot of pelagic microfossils (conodonts, holothurian sclerites, radiolarians) and even some macrofossils (Norian halobiids, monotids).

Because of the above discussed erroneous stratigraphic assignments of Upper Triassic-Liassic deposits both in the Csővár area and in the Buda Mountains, the existence of the Buda Line (like most of the faults with large-scale horizontal displacements, it is rather a fault zone that was additionally after the large horizontal displacements dissected nearly perpendicularly to its strike)

has not been recognized in most of the Hungarian paleogeographic reconstructions (e.g. KOVÁCS, 1982 and later papers, FÜLÖP, BREZNYANSKY & HAAS, 1987), despite the fact that not only the Upper Triassic, but also the Upper Eocene-Oligocene development (BÁLDI, 1986; BÁLDI & NAGYMAROSI, 1976) and according to the stratigraphic results of the present paper also the Liassic developments are very different SE and NW of the Buda Line.

Moreover, hypothetic positions of facies boundaries have been established in the Norian on the base of incorrect stratigraphic data, that are the base for several palinspastic reconstructions and paleotectonic hypotheses. On the base of these hypotheses, the geology of the neighbouring countries have been re-interpreted. Some of these reconstructions are critically discussed below.

❶ The base of all paleogeographic and paleotectonic hypotheses of KOVÁCS (1982 and later papers) is the hypothetic position of the facies boundary between Norian Main Dolomite west of the Vértes Mountains to Norian Dachstein Limestone east of it (e.g. Buda Mountains). However, as pointed out by KOZUR & MOCK (1991), the Main Dolomite/Dachstein Limestone transition lies in the Northern Bakony (far west of the assumed present-day place of this facies boundary) and in the Buda Mountains (far east of the assumed present-day place of this facies boundary) in the same stratigraphic level. Moreover, in the Buda and Csővár Nappe no Dachstein Limestone is present, but pelagic deposits that do not fit in the reconstruction by KOVÁCS and have been therefore ignored (transformed into the Lower Carnian for the Rhaetian Mátyáshegy Limestone or into the Lower and Middle Carnian for the pelagic Norian cherty dolomite). The facies boundary between Main Dolomite and Dachstein Limestone lies not in the area assumed by KOVÁCS and moreover not in N–S direction. In the Bakony, the Dachstein Limestone begins in the north earlier than in the south, therefore the facies boundary is there nearly perpendicular to the direction of the facies boundaries on which the model of KOVÁCS is based. In the Buda Mountains, Lower Norian Main Dolomite is present NW of the Buda Line. According to the hypothesis of KOVÁCS, Dachstein Limestone should be there present. Moreover, south of the Buda Line (according the hypothesis of KOVÁCS not existing) in the Lower Norian pelagic deposits are present, rich in *Metapolygnathus abneptis* and radiolarians. In the Triassic facies succession Main Dolomite and fully pelagic deep-water carbonates are not deposited immediately adjacent each other. Moreover, also here the direction of the facies "jump" is not W–E, but NNW-SSE. The connection of the Upper Triassic Alpine and Hungarian facies belts by KOVÁCS (1982) and KAZMER & KOVÁCS (1985) is therefore basically wrong, and therefore also the Triassic palinspastic reconstruction is basically wrong.

❷ In HAAS et al. (1990) and in other papers with KOVÁCS as co-author or partly written by KOVÁCS (FÜLÖP, 1989), the largest part of the Inner Western Carpathians (Silica Nappe and Inner Western Carpathian areas south of it) was taken out from the Western Carpathians and placed in the "Pelso Unit" (partly also designated as "Superunit"), a "conglomerate" of Vardar, Dinaric, Austroalpine and Adriatic nappe systems. The Silica Nappe shows clear facies transition to the northwards following nappes that remained in this model in the Western Carpathians. If we would apply this idea to the Alps, the Juvavic nappes or part of them must be placed in the Pelso Unit, the remaining Upper Austroalpine units in the Northern Calcareous Alps. The question of the southern boundary of the Western Carpathians is surely open to discussion, but it is unrealistic to place this boundary within a nappe system that originated from the northern shelf of the Meliata-Hallstatt ocean. The northernmost natural boundary would be the Meliaticum, but compared with the Alps also the Balaton Line–Buda Line would be a natural boundary, separating Adriatic nappes sensu FLÜGEL et al. in the NNW from Dinaric nappes in the SSE.
Even the "subunits" within the "Pelso Unit" consist of different tectonic units. The Transdanubian Central Range Subunit consists of Dinaric nappes SE of the Buda Line and of Adriatic nappes NW of it. The Bükk (or Borsod) Subunit consists of Vardar units (Bükk Mountains) and Meliaticum (e.g. Darnó-hegy between the Bükk- and Mátra Mountains). The Gemer Subunit comprises the Gemeric Paleozoic of unclear tectonic position, the Meliaticum (remnants of the Meliata-Hallstatt ocean) and the Silicicum (nappes that originated on the northern slope and shelf of the Meliata-Hallstatt ocean), the Igal Subunit comprises Outer Dinaric nappes with shallow-water Carboniferous, Permian and shallow-water and pelagic Triassic as well as nappes with ophiolitic melanges that contain Triassic siliceous shales (KOZUR, in press). The Rudabánya-Aggtelek Subunit comprises the Meliaticum, nappes that originated on its northern and southern slope and nappes that originate on its northern outer shelf. Also the Drauzug was placed in the Pelso Unit. In the latest pictures (e.g. KOVÁCS in EBNER et al., 1991) even the Vepor Unit was placed in the Pelso Superunit, but this may be a drawing mistake. Also without the Vepor Unit the Pelso Unit contains more tectonic units than the whole Alps. The Pelso Unit is an excellent example for contra-productive geology. The Pelso Unit would not be more heterogenous to put in it also the rest of the Alps south of the Flysch Zone, the rest of the Western Carpathians south of the Pieniny Klippen Belt, the Dinarids and the Vardar Zone. Then we could define it with the Alpine units of the former "k.u.k. Monarchie", to find any sense of this unit.

❸ The Penninicum is regarded as Austroalpine Unit in HAAS et al. (1990) and other papers with KOVÁCS as co-autor.

❹ In the same papers the Meliaticum is regarded as axial zone of the Vardar ocean, despite the fact that in the axial Vardar Zone the oceanic rifting was only in the Jurassic, whereas the oceanic rifting in the Meliaticum was in the Middle Triassic–Cordevolian. During the Lower and Middle Jurassic, the Meliata ocean has been subducted.

❺ The Bükk Subunit is regarded as displaced terrain of the Outer Dinarids, despite the fact that the Paleozoic to Jurassic development corresponds to the Vardar Zone.

❻ KOVÁCS et al. (1989) placed the Mecsek Mountains and most of the Tisza Unit besides the Tatrids, whereas a Lower Jurassic position in continuation of the Danish-Polish trough is assumed for this unit, that means outside the Tethys at the southern end of the Tornquist Line. No explanation is given, how the Mecsek Unit could cross the Pieninic oceanic realm to leave the Tethys area between the end of the Triassic and the be-

ginning of the Jurassic and how Tisza could come back (before the Middle Cretaceous) through the Silesian Trough, Magura ocean, Chorsztyn Rigde and Pieniny ocean from its Liassic extra-Tethyan position in a intra-Tethyan position.

❼ In HAAS et al. (1990) all units that were situated during the Jurassic at the outer margin of the Vardar ocean have been regarded as units from the northern margin of the Tethys, all units that were situated at the inner margin of the Vardar ocean have been regarded as units from the southern margin of the Tethys. However, the Jurassic Tethys does not consist of only one oceanic realm, the Vardar ocean, but of several oceanic and suboceanic realms, separated by areas with continental crust. The southern margin of the Tethys is, e.g., situated south of the Sicanian paleogeographic domain of Sicily, south of the Trodos ophiolitic belt etc. The northern margin of the Tethys was in the Jurassic north of the Magura ocean etc. The Jurassic Tethys cannot be restricted to the South Penninicum and to the Vardar Zone!

The unification of totally different tectonic units in a hypothetic "Pelso Unit", the stratigraphic, palinspastic and paleotectonic misinterpretation within several tectonic units of the "Pelso Unit" and the misinterpretation of the Triassic of the Mecsek Mountains and of Tisza as a whole as Germanic Triassic from the margin of the Germanic Basin are the main obstacles for re-evaluation of the complicated geologic structure of Hungary. The "Germanic Triassic" of the Mecsek Mountains as evidence for a Triassic position of this area (and of Tisza) at the margin of the Germanic Basin has been repeated since KOVÁCS (1982) in numerous papers without any new argument. Neither KOVÁCS nor his co-authors have ever worked in the Germanic Triassic and similar sequences in other part of the world. Only so is explainable that they have not recognized the total faunistic differences and strong differences in the facies and facies successions between the Triassic of the Germanic Basin and the Triassic of the Mecsek Mountains. None of the endemic Germanic Triassic fossils, like the *Celsigondolella* lineage or *Gondolatus* at the conodonts, even not one of the brackish-water ostracod species of the northern marginal seas from the Germanic Basin until the Pricaspian Basin or the well known Germanic ammonoid genus *Ceratites* are known from the Mecsek Mountains. Hypersaline beds, characteristic for the Illyrian (Middle Muschelkalk) and for the Lower and Upper Carnian (Lower Gypsum Keuper, Upper Gypsum Keuper) of the Germanic Basin are entirely missing in the Mecsek Mountains. Such beds occur even in many areas within the Tethys (hypersaline horizons in the Raible Beds).

A lithostratigraphic three-fold subdivision in a predominantly sandy, often continental lower part, a marine middle part and a hypersaline, lagoonal, brackish or continental upper part can be found in many parts of the world. Such "Germanic Triassic" occurs not only in the Germanic Basin, but for instance also near the lake Titicaca in Bolivia and Peru, in Arizona, in Spain, in North Africa, Jordan and China, to list only areas studied by the present author. Such Triassic occurs also inside the Tethys (Apulia, Tisza, China). It is impossible that the Mecsek Mountains were situated near to all these areas.

This "Germanic" facies succession indicates similar climate (only present in the tropical and subtropical belt) and a transgression of a shallow-water sea in an area that was during the Triassic situated predominantly above or near the sea level. This transgression may indicate a sea-level high stand (especially during the Lower and Middle Anisian and Lower and Middle Ladinian) or it may be caused by subsidence in areas that are situated during the Triassic mainly above the sea-level or near to the sea-level.

At least correct quotation should be expected. KOVÁCS et al. (1989) intentionally wrote that KOZUR (1984 a, b) supposed an North African-Arabian origin of the Tisza Superunit. Like above, I have written in these and other papers that the "Germanic Triassic" cannot be used for paleogeographic reconstructions without consideration of faunal evidences, because it occurs not only in the marginal seas north of the Tethys, but also in marginal seas south of the Tethys (e. g. in North Africa and on the Arabian Peninsula), and also inside the Tethys.

I have never used, like KOVÁCS, alone lithologic similarities for palinspastic reconstructions, but only in combination with the same event succession, the same fauna in facially identical deposits, and even then must be evaluated, whether these areas where in a certain time-interval adjacent each other or not. The Bihor "Autochthon" of Romania and the Triassic of the western Southern Alps at Mte. San Giorgio have the same Scythian–Carnian lithofacies, the same event succession and the same faunal content. Despite this fact it is not probable that they were in this time situated adjacent each other. Rather the same paleogeographic position with respect to the distance from the Southern Tethys and the position on the same plate is indicated that must not mean adjacent position.

According to all my reconstructions, also explained in the quoted papers KOZUR (1984 a, b), Tisza was situated at the northern (outer) margin of the Southern Tethys. The African-Arabian shelf was situated on the southern margin of the Southern Tethys. So, in all my paleogeographic reconstructions for the Tethyan Triassic the largest part of the Tethys was situated between Tisza and North Africa or the Arabian Peninsula. The quotation in KOVÁCS et al. (1989) is therefore intentionally wrong.

The discovery of Jurassic in the Csővár area indicates that in Hungary in several decisive important regions (e.g. Csővár area, Buda Mountains, Bükk Mountains, Darnóhegy area) even well exposed, fossil-rich sequences, intensively studied more than 100 years, have been incorrectly dated. There is no reason to change palinspastic and paleotectonic reconstructions of well exposed and well studied units in neighbouring countries on the base of mostly covered Early Mesozoic sequences of Hungary. Paleogeographic and paleotectonic preconceptions are necessary in a country like Hungary, where large parts of the Early Mesozoic are covered by Tertiary rocks and where the surface outcrops are often poor compared with the Alps and Western Carpathians. However, these preconceptions should not become a dogma that hinders further scientific progress.

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