



First evidence of *Pseudofurnishius* (Conodonta) in the Triassic of Hungary

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With 1 Text-Figure and 1 Plate



Ungarn
Cordevol
Conodonten
Paleogeographie

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Erster Nachweis von *Pseudofurnishius* (Conodonta) in der Trias Ungarns

Zusammenfassung

Die Conodontengattung *Pseudofurnishius* ist sehr charakteristisch für die Südtethys und ihre Randbereiche und Randmeere. Das Reproduktionsareal von *Pseudofurnishius* war das pelagische offene Meer der Südtethys, wo diese Gattung in roten Hornsteinknollenkalken und zwischenlagernden roten und grünlichen Tonen besonders häufig ist. Von diesem Gebiet aus besiedelte *Pseudofurnishius* besonders den Südrand und die südlichen Randmeere der Tethys, wo die Gattung sogar nahe der ökologischen Toleranzgrenze für Conodonten in Plattformkarbonaten und schlecht durchlüfteten flachen Becken relativ häufig auftritt, z.T. in monospezifischen Faunen. Am Nordrand der Südtethys ist *Pseudofurnishius* im Westen (Balaton-Hochland) ein sehr untergeordnetes Faunenelement und kommt dort nur in Schichten sporadisch vor, die für Conodonten faziell besonders geeignet sind (pelagische, mikritische, oft bunte Kalke). Im Osten (südlichste Türkei) ist *Pseudofurnishius* auch am Nordrand der Südtethys häufig. Im dazwischen liegenden Bereich (Südrand von Tisza) ist *Pseudofurnishius* am Nordrand der Südtethys regelmäßig vorhanden, aber niemals dominant (3–15 % der Plattformconodonten).

In der Nordtethys fehlt *Pseudofurnishius* in allen Faziesbereichen von Primorje (nahe Vladivostok, Rußland) im Osten bis zu den Nördlichen Kalkalpen im Westen.

Die paläobiogeographische Bedeutung der Conodontenfaunen mit *Pseudofurnishius* und der *Theelia tubercula* Holothurienskerit-Assoziation wird diskutiert. Beide Faunen charakterisieren die Südtethys und ihre Randbereiche/Randmeere von Spanien im Westen bis mindestens Malaysia im Osten. Die begrenzenden ökologischen Faktoren für die nördliche Verbreitungsgrenze von *Pseudofurnishius* und *Theelia tubercula* wird diskutiert.

Abstract

The conodont genus *Pseudofurnishius* is very characteristic for the Southern Tethys and its margins and marginal seas. The reproduction area of *Pseudofurnishius* was the pelagic open sea of the Southern Tethys, where it is common especially in red nodular cherty limestones and intercalated reddish and greenish claystones and marls. From there it invaded especially the southern margin of the Southern Tethys, where it can be found even near the ecologic tolerance boundaries of conodonts in shallow water carbonates and restricted basins, often without any other conodonts. On the northern margin of the southern Tethys, *Pseudofurnishius* occurs in the W (Balaton Highland) very rarely and sporadically only in beds, most suitable for conodonts (pelagic micritic limestones). In the East (southernmost Turkey) *Pseudofurnishius* is also frequent on the northern margin of Southern Tethys. In the intermediate area (southern margin of Tisza) *Pseudofurnishius* is common, but not dominant (3–15 % of the platform conodonts) on the northern margin of the Southern Tethys.

In the Northern Tethys and their marginal seas, *Pseudofurnishius* is missing in all facies from Primorje (near Vladivostok, Russia) in the East until the Northern Calcareous Alps in the West.

The paleobiogeographic importance of the conodont faunas with *Pseudofurnishius* and the *Theelia tubercula* holothurian sclerite association is discussed. Both faunas characterize the Southern Tethys and its margin/marginal seas from Spain in the West to at least Malaysia in the East. The limiting ecologic factors for the northern boundary of distribution of *Pseudofurnishius* and *Theelia tubercula* is discussed.

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1. Introduction

Pseudofurnishius murcianus VAN DEN BOOGAARD is the most characteristic fossil for the middle Longobardian to Cordevolian (middle part of Upper Ladinian to Lower Carnian) of the Southern Tethys. This species is facially nearly independent and at the southern margin of the Southern Tethys and in its southern marginal seas *P. murcianus* can be observed even near the ecologic tolerance boundaries for conodonts, mostly in shallow-water limestones and dolomites, partly in deposits of restricted basins with oxygen deficiency (but still with some benthos). In such deposits *Pseudofurnishius murcianus* occurs in few beds between conodont-free rocks, partly in monospecific assemblages consisting exclusively of one ontogenetic stage. However, also *Pseudofurnishius murcianus* (like other conodonts) preferred pink pelagic limestones and intercalated reddish and greenish claystones and marls, where it occurs in the Southern Tethys in frequencies of 3–20%, rarely to 50 % of the total amount of platform conodonts. From this pelagic areas within the Southern Tethys, where all *Pseudofurnishius* species are present (reproduction area of *Pseudofurnishius*), *P. murcianus* invaded facially favourable areas at the northern and southern margin of the Southern Tethys and also facially not so favourable areas of the southern margin of the Southern Tethys and of its marginal seas. In these latter areas *Pseudofurnishius* is often present with monospecific faunas in few beds between predominantly conodont-free beds. This indicates repeated invasions of *Pseudofurnishius* from its pelagic reproduction areas within the Southern Tethys.

The accompanying conodonts in pelagic conodont faunas with *Pseudofurnishius* are *Budurovignathus mungoensis* (DIEBEL), *B. mostleri* (KOZUR), *Gladigondolella malayensis* NOGAMI, *G. tethydis* (HUCKRIEDE), *Paragondolella trammeri* (KOZUR), in the Cordevolian also *B. diebeli* (KOZUR & MOSTLER), *P. polygnathiformis* (BUDUROV & STEFANOV) and *P. tadpole* (HAYASHI). *Gladigondolella* and *P. trammeri* are dominating in the Longobardian, whereas in the Cordevolian *Gladigondolella* and *P. polygnathiformis* are dominating.

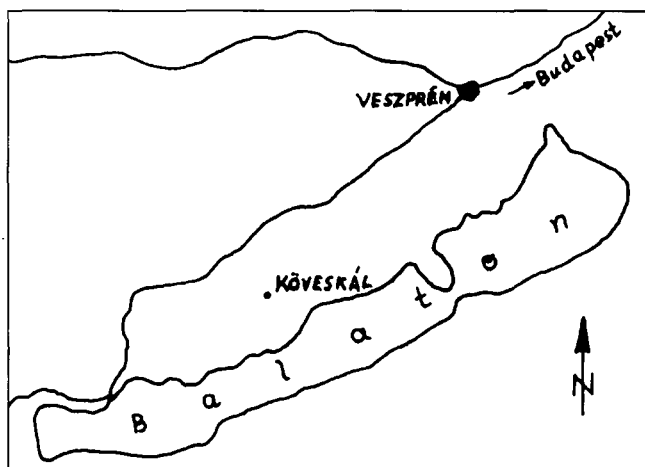
Other *Pseudofurnishius* species occur only in pelagic rocks of the Southern Tethys or in transitional facies between pelagic and shallow-water facies in the southern marginal seas of the Southern Tethys. These *Pseudofurnishius* species are missing in shallow-water carbonates and restricted basin facies.

On the northern margin of the Southern Tethys, *Pseudofurnishius* is very rare to common (see chapter 4.). Only *Pseudofurnishius murcianus* can be found that occurs there only in fully pelagic rocks, but not in shallow-water carbonate or restricted basin deposits.

In the Northern Tethys, its margins and marginal seas all *Pseudofurnishius* species are missing in any facies. For this reason, *Pseudofurnishius* is an ideal indicator for units that belong to the Southern Tethys or its margin/marginal seas. This is still confirmed by the fact that in all areas, where *Pseudofurnishius* is common, the *Theelia tubercula* holothurian sclerite association is present that occurs even in samples, where conodonts are missing. Moreover, the *Leviella bentori*-*Leviella sohni* ostracod association is likewise restricted to areas, where *Pseudofurnishius* occurs.

2. Geological Setting and Previous Work

In the section at the cemetery of Köveskál in the Balaton Highland (location see Text-Fig. 1) pelagic Middle Fas-



Text-Fig. 1.
Location map.

anian to Cordevolian rocks are continuously exposed. The macrofauna of this section (mainly *Daonella*, some ammonoids) was already studied at the beginning of this century (LÓCZY, 1916). First micropaleontologic studies (conodonts, holothurian sclerites, ostracods, foraminifers, radiolarians) have been carried out by KOZUR & MOSTLER (1971) and KOZUR (1988 a, b). This work was interrupted by the confiscation of the investigated, but not yet published new material of KOZUR and MOSTLER (mainly radiolarians, conodonts, a part of the material was given to Dr. KOVÁCS) in a political affair in 1985. Under the new leadership of the Hungarian Geological Institute by Prof. Dr. GAAL, the material was given back to the author, and the investigation can be now continued. The conodonts and conodont succession will be published by KOZUR (in press a, b), the radiolarians will be published by KOZUR & MOSTLER (in press a, b). A detailed geologic column will be published in these papers. For lithologic description and short remarks to the conodont and radiolarian successions see KOZUR (1988 a).

Pseudofurnishius murcianus VAN DEN BOOGAARD was found in sample 13/1984/V 29, about 4.5 m above the base of the Füred Limestone Formation (light gray, light yellowish-gray, pinkish-gray thick-bedded micritic pelagic limestones).

3. Biostratigraphic and Biofacial Evaluation

Pseudofurnishius murcianus is accompanied in sample 13/1984/V 29 by the following platform conodont species: *Budurovignathus cordevolicus* n. sp. (description in a separate paper, this journal), *B. diebeli* (KOZUR & MOSTLER), *B. mostleri* (KOZUR), *Gladigondolella malayensis* NOGAMI, *Paragondolella polygnathiformis polygnathiformis* (BUDUROV & STEFANOV) and *P. foliata inclinata* (KOVÁCS). The joint occurrence of *B. diebeli* and *P. polygnathiformis* is characteristic for the Cordevolian.

Cordevolian age is also indicated by the advanced *Pseudofurnishius* (small mono-platform type with strongly reduced platform). This morphotype is characteristic for the Cordevolian. It represents probably an independent subspecies, but in the moment the exact separation from juvenile *P. murcianus murcianus* is not yet possible. All Cordevolian *Pseudofurnishius* associations consist exclusively of this morphotype.

Gladigondolella malayensis and the above *Paragondolella* species are typical pelagic elements. The pelagic character of the rocks is also indicated by the rich occurrence of radiolarians that are unfortunately calcified and cannot be solved from the limestone. Also the under- and overlying beds contain typical pelagic faunas (ammonoids, *Daonella*, pelagic conodonts, radiolarians).

4. Paleobiogeographic Importance of the Occurrence of *Pseudofurnishius* in the Cordevolian of the Balaton Highland

As known since long time, the Balaton Highland belongs to the northern margin of the Southern Tethys. It has many similarities with the Southern Alps (e.g. almost identical Scythian successions, thick pietra verde in the Ladinian, distinct Raibl event in the Middle Carnian), but also some similarities to the Northern Alps. In this situation the very rare presence of *Pseudofurnishius* in upper Longobardian or Cordevolian pelagic limestones was predicted by GULLO & KOZUR (1991). As known from other areas at the northern margin of the Southern Tethys (Välani Nappe of Northern Apuseni Mts., Malaysia), *Pseudofurnishius murcianus* occurs there in pelagic limestones of uppermost Ladinian to Lower Carnian age. The conodont-rich pelagic lower Füred Limestone Formation of uppermost Ladinian to (mostly) Cordevolian age was therefore the best "candidate" for discovery of *Pseudofurnishius*. Re-sampling in the Köveskál section yielded *Pseudofurnishius murcianus* in one sample in a frequency of about 1 % of the total conodont fauna. By this the outstanding importance of *Pseudofurnishius* as indicator for the Southern Tethys during the Upper Ladinian and Lower Carnian has been confirmed.

This view was first expressed by KOZUR (1979, 1980), who predicted already in this time the presence of *Pseudofurnishius murcianus* in the Southern Alps (found later by NICORA, 1981). However, this view was repeatedly and polemically rejected by KOVÁCS (the last time in KOVÁCS et al., 1989). Generally, KOVÁCS does not quote papers that present data that do not fit in his paleogeographic pre-conceptions. If he cannot avoid such references, he quoted such papers only for polemical rejections that are mostly based on incomplete or even incorrect quotations. To prove the Triassic northern position of Tisza and of the Välani Nappe (with the typical Southern Tethyan Cordevolian association with *Pseudofurnishius murcianus* and *Theelia tubercula*), KOVÁCS regarded *Pseudofurnishius murcianus* in contrast to present data as a facies fossil that occurs almost exclusively in shallow restricted basin facies and he predicted that this genus will be found in such facies in the northern Tethys. This unproven assumption is not very realistic. Alone KOZUR, MOCK and MOSTLER have investigated more than 1000 limestone samples in the northern Tethys and their marginal seas from restricted basin facies of Late Ladinian and Early Carnian age, but *Pseudofurnishius* and the *Theelia tubercula* association could not be found. Moreover, the base for the assumption that *Pseudofurnishius* occurs almost exclusively in restricted basin facies, is unclear. KOVÁCS has never investigated rocks with *Pseudofurnishius* and from the literature only two occurrences of *Pseudofurnishius* in restricted basin facies are known. The majority of the occurrences of *Pseudofurnishius* is from shallow-water platform carbonates, rich in benthos.

Before KOVÁCS (in an appendix to KOVÁCS et al., 1989) rejected the importance of *Pseudofurnishius* and *Theelia tuber-*

cula as indicators for the Southern Tethys and its margin/marginal seas, KOVÁCS et al. (1989) used incorrect quotations for polemics against the data that the southern margin of Tisza has a Southern Tethyan Upper Ladinian and Cordevolian fauna to prove his hypothesis of the Triassic position of Tisza at the margin of the Germanic Basin. KOVÁCS et al. (1989, p. 91) wrote:

"... An origin on the North African-Arabian shelf (as supposed by KOZUR, 1984 a, b, because of some common features with the Libyan Triassic) is also impossible, for the Tisza Superunit could not have been transported across the isopic zones of the Outer Hellenides and Outer Dinarides. The faunal arguments raised by KOZUR (1979, 1984 a, b) for the southern origin of the Tisza Superunit cannot be unambiguously interpreted as "southern" (see Appendix) ..."

Unfortunately the co-authors of KOVÁCS have overtaken this intentionally incorrect quotation without reading the quoted original papers. Neither in KOZUR (1984 a, b) nor in any other paper I have placed the "Tisza Superunit" (nappe pile) during the Triassic on the North African-Arabian shelf, because this would contradict totally my view that between Tisza and the North African-Arabian shelf during the Triassic the entire Southern (main) Tethys was situated. In the quoted (and other) papers I have pointed out that the "Germanic Triassic" of Tisza (what is really not a Germanic Triassic, see KOZUR & MOCK, 1987 a – a paper, not quoted by KOVÁCS) cannot be used as an argument for placing Tisza during the Triassic on the margin of the Germanic Basin, because such lithostratigraphic units as "Buntsandstein", "Muschelkalk" and "Keuper" are not restricted to the northern margin of the Tethys. They occur also on the North African-Arabian shelf at the southern margin of the Southern Tethys (as well as, e.g. in Arizona, China or at the Lake Titicaca in Bolivia), areas that cannot be placed at the margin of the Germanic Basin. I have chosen the example of the North African-Arabian shelf to demonstrate that a development, lithologically similar to the Germanic Triassic (but faunistically totally different!), can be present in different areas separated during the Triassic by an ocean. Because KOVÁCS and KOVÁCS and co-authors have located Tisza during the Triassic and Jurassic beside entirely different units separated in that time by oceans (Tatricum, Czorsztyn Ridge between Pieniny and Magura ocean, European platform in the underground of Flysch Carpathians, European platform in continuation of the Danish-Polish Trough, in the Jurassic partly also south of the Bükk Mts.), I have chosen with the North African-Arabian shelf an area with "Germanic Triassic", that was not – and will not be – correlated with Tisza by KOVÁCS or any other author. By this was demonstrated that the comparison of selected lithostratigraphic units and especially of the widely distributed "Germanic Triassic" for paleogeographic reconstructions without consideration of the faunas and the entire geologic evolution is contraproductive.

As a further step by KOVÁCS et al. to reject the southern origin of *Pseudofurnishius*, all fossil data that support the southern origin of *Pseudofurnishius* have been discredited.

"... Knowledge of other groups (such as ostracods, holothurian sclerites, and radiolarians) is still at an elementary level and therefore they are not suitable for detailed statistical paleobiogeographic analysis at the present time. Certain paleontologic "arguments" have recently been published in support of a southern origin of the Tisza Superunit (KOZUR, 1979, 1984 a, b); however, they suffer from the above-mentioned deficiencies ..." (KOVÁCS et al., 1989, p. 88).

The fact that the knowledge of KOVÁCS about the above mentioned fossil groups is seemingly at an elementary stage (as he wrote himself) does not exclude the use of these well investigated groups for paleobiogeographic

reconstructions. Concerning the holothurian sclerites KOVÁCS (appendix to KOVÁCS et al., 1989, p. 98) demonstrates that he has not understood the problematic of the paleogeographic distribution of this group, well documented in numerous papers by MOSTLER, KRISTAN-TOLLMANN, MOCK, KOZUR and others. He wrote:

"... The holothurian argument is based on the occurrence of *Theelia tubercula* (see KOZUR, 1979), thought to be characteristic of south Tethyan margin. However, in contrast to the Jurassic ammonoids and brachiopods, Triassic holothurian sclerite associations have never been subject to detailed statistical evaluation dealing with the whole fauna, and the knowledge of the Triassic holothurian sclerites and data on their occurrence are still insufficient for a detailed statistical evaluation as was carried out for the Jurassic (see VÖRÖS, 1980, 1984 b) ..."

The holothurian taxonomy is in a by far better stage than the conodont taxonomy and the distribution of holothurian sclerites in the European Tethys is well known. Statistical evaluations of the occurrence of a species within the total fauna of this group are only useful, if the different paleobiogeographic provinces are characterized by different percentages of this species within these faunas. In the case of *Theelia tubercula*, this species is never present in holothurian-rich faunas of the northern Tethys and their margins/marginal seas, whereas this species is the index species for the Upper Ladinian and Lower Carnian of the Southern Tethys (KRISTAN-TOLLMANN, 1963, HUDDLE, 1970, KOZUR & SIMON, 1972, KOZUR et al., 1985, SADDIEDIN & KOZUR, 1992). The statistical frequency value for *T. tubercula* in Longobardian and Cordevolian holothurian sclerite associations of the Northern Tethys and its margins will be always 0, a value that is clear also without statistical analysis.

The same is the case with the ostracods. More than 90 % of Anisian and Ladinian brackish water ostracods of the Germanic Basin can be traced until the Pricaspian depression, more than 2000 km east of the Germanic Basin. None of these species is known in brackish water deposits of the Mecsek Mts., that according to the reconstruction by KOVÁCS (1982 and later papers) was situated adjacent to the Germanic Basin during the Triassic. The only identical species, the Carnian *Simeonella brotzenorum alpina* WIENHOLZ & KOZUR is an ubiquitous form, common also in the marginal parts of the Southern Tethys.

KOVÁCS et al. (1989) repeated then several faunal/floral "arguments" of KOVÁCS (1982 and later papers) for a northern position of Tisza that had been rejected by KOZUR (1984 a, b) and KOZUR & MOCK (for the last time in KOZUR & MOCK, 1987 a, b, 1988). As argument for the proximity of the Bihor "Autochthon" to the (eastern) Germanic Basin, the presence of *Nothosaurus* and *Tanystropheus* in the Peștiș Shale has been quoted. Again, these reptiles are both designated as reptiles of poor swimming capacity. It is well known that *Nothosaurus* was an active and good swimmer. Its remnants are known even from the centre of the Germanic Basin, several 100 km away from any coast line. This mode of life was seemingly the reason, why *Nothosaurus* is present both in the Northern and Southern Tethys and in their marginal seas. This ubiquitous genus cannot be used therefore as argument for a position of the Bihor "Autochthon" at the margin of the eastern Germanic Basin.

Tanystropheus occurs near the Anisian/Ladinian boundary, where it is present in the Peștiș Shale of the Bihor "Autochthon", in the Grenzbitumen Zone of the Tessin Alps and in the adjacent southwestern part of the Germanic Basin. Moreover, it is known from several places along the southern margin of the Southern Tethys (e.g. Israel).

In the eastern part of the Germanic Basin, according to the reconstruction of KOVÁCS adjacent to the Bihor "Autochthon", *Tanystropheus* is not more present above the Lower Anisian (there represented by a different species). Hardly possible to imagine that *Tanystropheus longobardicus* invaded to the Bihor "Autochthon" from an area, where it is not present. The occurrences of this species in the southwestern Germanic Basin are about 1000 km away. Because all occurrences of *Tanystropheus longobardicus*, with exception of the southwestern Germanic Basin (far away from any possible Triassic positions of the Bihor "Autochthon" and opposite to the occurrences in the Tessin Alps) are situated on the margin of the Southern Tethys, the occurrence of this reptile genus cannot be regarded as evidence for a Triassic position of Tisza at the northern margin of the Northern Tethys.

It is interesting that in all areas, where *Pseudofurnishius* is present in Longobardian and Cordevolian rocks, the Upper Permian contains a certain percentage of Gondwanide sporomorphs, indicating also for the Permian a southern position. KOVÁCS (appendix to KOVÁCS et al., 1989, p. 98) rejected also this evidence for a southern position of Tisza during the Permian by the following statement:

"... According to BARABÁS-STUHL (pers. comm.), the proportion of Gondwana elements in the Permian-Triassic palynoflora of the Mecsek-Vilány Triassic is 8–10 %, the rest is Germanic. I think that, from a paleobiogeographic point of view (whether or not the Mecsek Mountains at that time were part of the North or South Tethyan margin), the predominance of Germanic elements (90–92 %) is decisive ..."

The above data, but in exact form, have been published by BARABÁS-STUHL (1981). There was stated that the Upper Permian (not Permian-Triassic) has a certain percentage of Gondwanide sporomorphs. There was no word that the remaining sporomorphs are "Germanic" elements. Seemingly KOVÁCS, who has never worked on sporomorphs, has the opinion that those sporomorphs of Late Permian age that are not Gondwanide elements, must be Germanic elements. In the Upper Permian no "Germanic" sporomorphs (restricted to this area and adjacent regions) are known. The "Germanic" Upper Permian sporomorphs sensu KOVÁCS of the Mecsek Mts. (like *Falcisporites zapfei*, *Klausipollenites schaubergeri*, *Lueckisporites virkkiae*) are ubiquitous forms, known from Greenland to India or even to Australia. Most of these "Germanic" sporomorphs have their stratum typicum in the Southern Alps that surely were never part of the Germanic Basin.

Therefore the presence of Gondwanide sporomorphs in the Mecsek Mts., Southern Alps etc. (but not in the Germanic Basin) indicates a southern position of the Mecsek Mountains in the Permian, compared with the Germanic Basin.

The above statement of KOVÁCS about the preference of the "Germanic" Upper Permian sporomorphs in the Mecsek Mts. do not show too much knowledge about the topic. Like in other papers, KOVÁCS made at first a hypothesis and tried then to push the data into this hypothesis. After KOVÁCS and KOVÁCS et al. (1989) have intentionally discredited all faunal evidences for a southern position of Tisza (see above), the importance of *Pseudofurnishius* as indicator for southern origin is rejected. As mentioned above, also in this case the quotations and assumptions are not correct. Despite the fact that only in two areas *Pseudofurnishius* was reported from shallow restricted basins (Outer Dinarides, e.g. RAMOVŠ, 1977, Southern Alps, NICORA, 1981) KOVÁCS (appendix to KOVÁCS et al., 1989, p. 99) wrote about *P. murcianus*:

"... This species is characteristic of widespread shallow restricted basin environments in the southern and western part of the western Tethys (HIRSCH, 1976; PARNES et al., 1985). In all reported occurrences, *Pseudofurnishius murcianus* constitutes a monospecific assemblage, and only *Metapolygnathus mungoensis* is sometimes associated with it ..."

In the latter case, of course, the conodont fauna is not monospecific. The mentioned occurrences do not belong to the southern and western part of the western Tethys, but to marginal seas south and west of the Southern Tethys. None of these occurrences has derived from restricted basin facies, but all from shallow water carbonates with rich benthos. More than half of the investigated occurrences is not monospecific, but contain also *Budurovignathus mungoensis*, *B. mostleri*, in the Cordevolian also *B. diebeli*. Rarely gondolellid conodonts are present. Restricted basin facies with *Pseudofurnishius* is only known from the Outer Dinarides and Southern Alps. No pelagic rocks of Longobardian and Cordevolian are present in the marginal seas south and west of the Southern Tethys, so that the facies dependence of *Pseudofurnishius* could not be studied in this area.

CATALANO et al. (1988, 1990), KOZUR (1989) and GULLO & KOZUR (1991) reported rich faunas with *Pseudofurnishius* together with *Gladigondolella*, *Paragondolella trammeri* (KOZUR), different *Budurovignathus* species. The frequencies of *Pseudofurnishius*, present with different species, lies in these pelagic conodont faunas between 3 % and 50 % of the total platform conodont fauna.

The following remarks of KOVÁCS to the occurrence of *Pseudofurnishius murcianus* (appendix to KOVÁCS et al., 1989, 99–100) are therefore unsubstantiated:

"... The locality in the Apuseni Mountains is the only place where it occurs together with typical pelagic forms such as ... and is not the dominant element of the association (KOZUR, 1980, p. 87; the sample was shown to me several times by Dr. H. KOZUR...). In my opinion, from a paleobiogeographic point of view, the majority of the fauna should be taken as a rule and this occurrence of *P. murcianus* should therefore be considered as a unique exception where it occurs with an assemblage of pelagic elements ..."

As already stated by GULLO & KOZUR (1991) the repeatedly published remarks of KOVÁCS that only one sample with *Pseudofurnishius* and pelagic conodonts in one area (Northern Apuseni Mts.) was present, is incorrect. All investigated samples from the Cordevolian of the Strimtura section have yielded *Pseudofurnishius murcianus* together with pelagic conodonts. This section was sampled, because the present author had recognized before in the material of MIRĂUTA, Bucuresti, *Pseudofurnishius murcianus* together with pelagic conodonts. Such association is, moreover, already known since long time from Malaysia (NOGAMI, 1968), again from the margin of the Southern Tethys. It is therefore not an "unique exception" as recently demonstrated by CATALANO et al. (1988, 1990), KOZUR (1989), GULLO & KOZUR (1991). In Western Sicily *Pseudofurnishius* occurs together with pelagic conodonts and other pelagic faunas in reddish, cherty nodular limestones, reddish and greenish-gray claystones and marls and red radiolarites.

The view of KOZUR (1979, 1980) and KOZUR & MOCK (1987, 1988) that *Pseudofurnishius* is a genus that occurs in nearly all conodont-bearing facies from pelagic rocks to shallow-water platform carbonates has been therefore confirmed. The assumption of KOVÁCS that *Pseudofurnishius* is a facies fossil of shallow restricted basins was not supported by any data or his own investigations. It was born to have an "argument" against the paleogeographic significance of *Pseudofurnishius* as indicator for southern origin. But paleobiogeographic reconstructions that reject all data that do not fit into his preferred model are not very useful as could be demonstrated on this example.

Very important for the paleogeographic reconstructions is the question, what were the limiting factors for the distribution of faunal groups. The presence of Gondwanide Upper Permian sporomorphs in all areas, where *Pseudofurnishius* was later present in the Upper Ladinian and Lower Carnian indicates that the limiting factors are geographically related and *Pseudofurnishius* and the accompanying other faunal elements, like the *Theelia tubercula* holothurian sclerite association, indicate original southern positions of the units in which they occur. This position can have changed during the geologic evolution. The presence of brachiopods and ammonoids of European affinity on Tisza during the Lower and Middle Jurassic is therefore not a contradiction to Permian and Triassic fossil associations of southern affinity (see KOZUR & MOCK, 1987, 1988).

It is highly interesting that also the Anisian brachiopods indicate southern affinities for Tisza. According to PEVNÝ (1988), the Anisian brachiopods of the Alps, Western Carpathians and Northern Turkey are very similar to each other. The Anisian brachiopod fauna of the Germanic Basin is likewise very similar to these faunas. However, the brachiopod faunas of the Bihor "Autochthon" are entirely different, but very similar to brachiopod faunas of the Sarajevo area (Bosnia-Herzegovina, Dinarides).

In the Pliensbachian the picture is different, but unfortunately, no data are present from the Dinarides. The brachiopod faunas of Tisza have northwest European affinity, different from the Mediterranean faunas of the Alps and Western Carpathians. However, this picture is difficult to explain by paleogeographic distribution. The Penninic ocean was not yet open in the Pliensbachian. So there was no oceanic barrier between the Germanic Basin and the Alps. Even, if the earliest rifting began in the Liassic, an oceanic trough would be so narrow that it could not be an effective barrier for distribution of brachiopods. Very interesting is in this connection the Pliensbachian brachiopod fauna of the Antalya Nappes in southernmost Turkey (PRO-SOROVSKAYA & VÖRÖS, 1988). This fauna is identical with the brachiopod fauna of Tisza. However, independent from the view about the original position of the Antalya Nappes, they were surely never situated at the European margin and they originated surely south of the continuation of the Vardar ocean. A position similar to that of the Subpelagonian Nappes is probable. At least, the Antalya Nappes were not situated more near to stable Europe than the Subpelagonian Nappes. The autochthonous Pisidian Triassic is mostly regarded as the northern continuation of the depositional area of the Antalya Nappes. If this is correct, we would have exactly the same Triassic–Jurassic faunal successions as at the southern margin of Tisza: *Pseudofurnishius* in the Upper Ladinian and Lower Carnian (NICORA, 1981 and own material) and northwest European brachiopods in the Pliensbachian.

Because the Antalya Nappes originated south of the Izmir-Ankara Belt (continuation of the Vardar Zone) and south of the Cimmeric ocean ("Paleotethys" sensu SENGÖR [1985], continuation of the Meliata–Hallstatt ocean, see KOZUR [1991a,b]), the northwest European Pliensbachian brachiopods of this area cannot be used as evidence that these nappes originated from the margin of stable Europe. But in the same moment, we cannot use anymore the same Pliensbachian brachiopod fauna as evidence for a Pliensbachian position of Tisza at the margin of stable Europe. Because the Antalya Nappes have their continuation in parts of the Hellenides and Dinarides, also there European Pliensbachian brachiopods may be

present and, like in the Anisian, the faunal connection of Tisza may be through the Dinarides.

The distribution of the Pliensbachian brachiopods is either unrelated to the paleogeography, but controlled by other factors or the northwest European Pliensbachian brachiopods are also present at the southern margin of the Tethys (Circum-Tethyan distribution). In this latter case their presence would indicate either relations to stable Europe or to the Southern Tethys. The Mediterranean fauna would than be a fauna inside the Tethys. In any case, the Pliensbachian brachiopods are no more any evidence for the position of Tisza at the margin of stable Europe.

Because *Pseudofurnishius* is mostly accompanied by the *Theelia tubercula* holothurian sclerite association, the limiting factors for the distribution of these two groups have to be regarded together. The best explanation for the very different Longobardian and Cordevolian microfaunas of the Southern and Northern Tethys would be a land barrier and really such a barrier is present in several places. In the Pisidian Triassic of southernmost Turkey with a lot of *Pseudofurnishius* an increasing pelagic influence can be observed toward the south. North of the Pisidian Triassic the Rhaetian is transgressive. Therefore the Pisidian Triassic was situated at the northern margin of the Southern Tethys. North of it, during the Upper Ladinian and Lower Carnian a subaerial elevation (land with denudation) was present that was in that time a faunal barrier against all more northern units. A similar faunal barrier was Tisza. At its southern margin *Pseudofurnishius* is present. In its northern part (e.g. Mecsek Mts.) Upper Ladinian to Carnian fresh-water to brackish deposits are present that are a perfect barrier against the migration of conodonts and holothurians. Also the immediately underlying beds, mostly limestones in the Mecsek Mts. and dolomites in the southward situated Villány Mts., are free of conodonts and holothurian sclerites. If Tisza was part of the escape structure of the North Alpine-West Carpathian block (KOZUR & MOCK, 1987, 1988; SCHMIDT et al., 1991) so far was not taken into consideration by these authors that also Tisza could be part of the escaped block, separated by a transform fault), then also the strong faunal differences between the Northern and Southern Alps can be well explained. If not, a primary continuation of the Triassic development of Tisza toward the west is probable. The evidence of the Meliata-Hallstatt sphenocasm and of its southern margin in the Northern Calcareous Alps (KOZUR & MOSTLER, 1992) with shallowing toward the south and silty-sandy input during the Lower Anisian and Pelsonian indicate the presence of an at least partly elevated area between the Northern Calcareous Alps and the Southern Alps.

However, there was surely not a continuous elevated area (subaerial or extremely shallow-water) between the Southern and Northern Tethys. Thus, still other barriers responsible for the northern limit of *Pseudofurnishius* must be present.

The Germanic Basin was in the Upper Ladinian clearly connected to the marginal seas of the Southern Tethys with *Pseudofurnishius* and *Theelia tubercula*. This is indicated by immigration of such ammonoid genera as *Allocceratites* through the Burgundian Gate (KOZUR, 1975). However, *Pseudofurnishius* never reached the German Basin, that was rich in Upper Ladinian conodonts. Perhaps, the Germanic Basin had in this time an unusual salt composition (similar to the Recent brackish water of the Caspian Sea), because it was nearly isolated over several million years with strong fresh-water input from the NE and with strong evaporation

due to the semiarid climate. During the Upper Ladinian fresh-water to brackish water prevailed in the NE, but hypersaline gypsum-bearing beds occurred contemporaneously in restricted gulfs at the margin of the Vindelician Land in the SE or at the Gallic block in the West (KOZUR, 1971, 1976). However, such salt content differences that give a good explanation for the faunal barrier against the Germanic Basin were surely not present between the Southern and Northern Tethys.

The oceanic-suboceanic deep-water part of the Southern and Northern Tethys could be also a barrier, but not for the westernmost part, where these oceanic-suboceanic troughs became narrower and narrower and finally disappeared. However, the northern margin of the Southern Tethys has in the east rather rich *Pseudofurnishius* faunas (Pisidian Triassic). Therefore there, were the Southern Tethys was broadest, it was not a barrier for the migration of *Pseudofurnishius*. Further in the west the frequency of *Pseudofurnishius* decreased at the northern margin of the southern Tethys. In the Vålani Nappe of the Northern Apuseni Mts. the frequency of *Pseudofurnishius* was in the investigated samples and in the material of Dr. MIRĂUȚA between 3 % and 15 % of the platform conodonts. The conodont composition of the representative sample Str.-4 (500 g sample weight) is: *Budurovignathus diebeli* (KOZUR & MOSTLER): 7 specimens (25.9 %), *B. mostleri* (KOZUR): 5 specimens (18.5 %), *Gladigondolella malayensis* NOGAMI: 4 specimens (14.8 %), *Paragondolella polygnathiformis noah* (HAYASHI): 4 specimens (14.8 %), *P. tadpole* (HAYASHI): 3 specimens (11.1 %), *Pseudofurnishius murcianus* VAN DEN BOOGAARD: 4 specimens (14.8 %).

Still further in the west, in the Balaton Highland, *Pseudofurnishius* is at the northern margin of the Southern Tethys very rare (one specimen among 93 platform conodonts in the *Pseudofurnishius*-bearing sample, but most of the samples have not yielded any *Pseudofurnishius*, and therefore the percentage of *Pseudofurnishius* is still lower). Moreover, in shallow-water deposits and restricted basin deposits *Pseudofurnishius* is entirely missing also in conodont-rich samples. Therefore the conditions for *Pseudofurnishius* were in this area so bad that it occurs only in rocks with the most suitable facies for conodonts (pelagic micritic open-sea deposits). Very interesting that *Theelia tubercula* was so far not found in the Balaton Highland, where the North Tethyan Upper Ladinian–Lower Carnian holothurian association occurs. This indicates that at least in the area of the Balaton Highland an undisturbed migration of North Tethyan faunal elements onto the northern shelf of the Southern Tethys was possible. In the Southern Alps, in turn, the North Tethyan holothurian association is missing and the *Theelia tubercula* fauna is present. On the other hand, *Pseudofurnishius* is also very rare in the Southern Alps (at least, if we evaluate the present day data). The totally different Cordevolian holothurian associations between the Southern Alps and the Balaton Highland indicate that there was a faunal barrier between these two areas. If the Balaton Highland was originally situated further to the west this faunal barrier is still more difficult to explain.

One key for the explanation of the faunal differences between the Northern and Southern Tethys is the fact that the Southern Tethys has not yielded paleopsychrospheric ostracods in the Middle Triassic and Lower Carnian. Deep-water ostracods of this area lack totally all archaic elements, like *Acantoscapha* or *Tricorninacea*. Paleopsychrospheric ostracods occur only in cold bottom water below 500 m water depth (see KOZUR, 1991 c, d). Pelagic belts of the Northern Tethys, where paleopsychrospheric ostra-

cods are common in water depth below 500 m would be therefore a total faunal barrier both for *Pseudofurnishius* and for the *Theelia tubercula* association that are both warm-water faunal elements. The absence of these faunas in the Meliaticum and in any Unit north of it (largest part of the Western Carpathians and Northern Alps) is therefore easily to explain.

In the Balaton Highland paleopsychrospheric ostracods are present, at least in certain levels (not found in the bed with *Pseudofurnishius*). Despite its position on the northern margin of the Southern Tethys, it was involved in the oceanic water circulation pattern of the Northern Tethys. This would well explain, why *Pseudofurnishius* is so rare and *Theelia tubercula* is missing. Further toward the east, in the Pisidian Triassic of southernmost Turkey, a land barrier prevented the northern margin of the Southern Tethys from the deep-water circulation of the Northern Tethys. Therefore *Pseudofurnishius* is there also very frequent at the northern margin of the Southern Tethys.

The paleobiogeographic importance of the *Pseudofurnishius-Theelia tubercula* fauna can be summarized as follows: The northern limit of the *Pseudofurnishius-Theelia tubercula* fauna was defined by paleogeographic boundaries. This fauna is restricted to the Southern Tethys and its margin/marginal seas. The frequency of *Pseudofurnishius* at the northern margin of the Southern Tethys is influenced by some other factors, especially by bottom water temperature, salt content and elevated areas. As a whole, the following picture for the northern limit of the *Pseudofurnishius-Theelia tubercula* fauna can be given:

- The western marginal sea of the Southern Tethys with rich occurrences of *Pseudofurnishius* (Maghreb, Balears, Spain) was bordered in the north by a land mass. The Northern Tethys is not present north of this area. Immigration of the *Pseudofurnishius-Theelia tubercula* fauna in the Germanic Basin was not possible because of unusual salt composition in the nearly totally enclosed Germanic Basin with strong fresh-water influx in the NE and strong evaporation. Probably also the water temperature was lower than in the Southern Tethys.
- At the western end of the Cimmerian (Northern) Tethys in the Alps the Northern and Southern Tethys had a common shelf that is partly involved in the (cold) bottom water circulation of the Northern Tethys, indicated by the presence of paleopsychrospheric ostracods in the Balaton Highland that belongs to the northern margin of the Southern Tethys, but is seemingly directly connected to the southern shelf of the Northern Tethys. For this reason, the warm-water *Pseudofurnishius-Theelia tubercula* fauna is either missing (*Theelia tubercula* holothurian sclerite fauna) or extremely rare (*Pseudofurnishius murcianus* which is as a nektoplanktonic fossil more mobile). Despite the fact that the lithologic development is very similar to the Southern Alps, the Northern Tethyan *Theelia koeveskallensis* holothurian sclerite fauna is present.
- Further to the east, Tisza was the faunal boundary between the Southern Tethyan fauna (present at the southern margin of Tisza) and the Northern Tethyan fauna (present north of Tisza). Elevated areas within Tisza

during the Upper Ladinian and Lower Carnian (intra-tidal dolomites without conodonts and holothurian sclerites, fresh water and brackish deposits) were an effective barrier against the faunal exchange between the South Tethyan *Pseudofurnishius-Theelia tubercula* fauna and the North Tethyan *Theelia koeveskallensis* fauna. Further to the east very effective faunal barriers were present between the Northern and Southern Tethys. North of the Pisidian Triassic in southernmost Turkey (northern margin of Southern Tethys with a lot of *Pseudofurnishius*) a Triassic land mass was present (with transgressive Rhaetian) that was a very effective barrier against the faunal exchange between the Northern and Southern Tethys. Therefore the South Tethyan elements are here also at the northern margin of the Southern Tethys dominant elements against ubiquitous forms and Northern Tethyan elements are missing.

The *Pseudofurnishius* fauna of the Southern Tethys can be traced toward the East at least until Malaysia, where it occurs in pelagic conodont faunas (NOGAMI, 1968). The presence of *Pseudofurnishius* in the displaced terranes (or part of them) along the western margin of North America is probable, because also *Mosherella newpassensis* is present that belongs to the *Pseudofurnishius sosioensis* lineage and Permian faunas of the displaced terranes have rather Southern Tethyan character.

With the first evidence of *Pseudofurnishius murcianus* in the Balaton Highland, this species is now known from the entire Southern Tethys and its margins/marginal seas in Europe, North Africa, the Arabian Peninsula and southernmost Turkey. It is the best indicator for Southern Tethyan origin of a tectonic Unit. It occurs in nearly all conodont-bearing facies, especially frequent in pink or variegated micritic uncondensed limestones that are favoured also by the most other conodonts. However, in condensed Hallstatt limestones *Pseudofurnishius* may be missing. Other conodonts too are rare or missing in this facies, especially the stratigraphically important genus *Budurovignathus* (*B. truempyi* has not yet been found in Hallstatt Limestones, all other *Budurovignathus* species are rare in this facies).

Whereas the *Theelia koeveskallensis* fauna is a typical Northern Tethyan holothurian sclerite fauna, missing in the Southern Tethys (with exception of its northwestern margin, in the Balaton Highland), there are no conodont species restricted to the Northern Tethys. But some species, common in the Northern Tethys are rare in the Southern Tethys. For instance, *Paragondolella inclinata* (KOVÁCS) is rare in the Southern Tethys. It was not yet found in Hallstatt Limestones of Oman. It is extremely rare in pelagic rocks of Western Sicily, despite the fact that other pelagic conodonts, such as *Gladigondolella malayensis* (NOGAMI), *G. tethydis* (HUCKRIEDE), *Paragondolella trammeri* (KOZUR), *P. polygnathiformis* (BUDUROV & STEFANOV), are very common. At the northern margin of the Southern Tethys, *P. inclinata* is more frequent and in the Balaton Highland common. Therefore not only the holothurian sclerite fauna of the Balaton Highland shows Northern Tethyan character, but also the conodont fauna shows strong Northern Tethyan affinity and the Southern Tethyan element *Pseudofurnishius* is only very rare (explanation see above).

Plate 1

All figured conodonts are from the section at the cemetery of Köveskál, Balaton Highland (Hungary). They have all derived from the *Pseudofurnishius murcianus*-bearing sample Ko 13/1984/V/29 from the Füred Limestone Formation, 4.50 m above the base of this formation.
Cordevolian *Budurovignathus diebeli* Zone.

Fig. 1: *Gladigondolella malayensis* NOGAMI.

Rep.-no. 6/36/13/2/1985-10.

a) Upper view, $\times 78$.

b) Lateral view, $\times 94$.

Fig. 2: *Paragondolella foliata inclinata* (KOVÁCS).

Rep.-no. 6/36/13/2/1985-11, $\times 54$.

a) Lateral view.

b) Upper view.

Fig. 3: *Paragondolella polygnathiformis polygnathiformis* (BUDUROV & STEFANOV).

Rep.-no. 6/36/13/2/1995-9.

a) Lateral view, $\times 72$.

b) Upper view, $\times 66$.

Fig. 4: *Budurovignathus cordevolicus* n. sp.

Holotype (description in a separate paper, this journal), Rep.-no. CK 1988 VI-5, $\times 160$.

a) Oblique lateral view.

b) Upper view.

Fig. 5: *Ozarkodina torta* (MOSHER).

Ozarkodiniform element of *Pseudofurnishius*, *Mosherella* and advanced *Budurovignathus*.

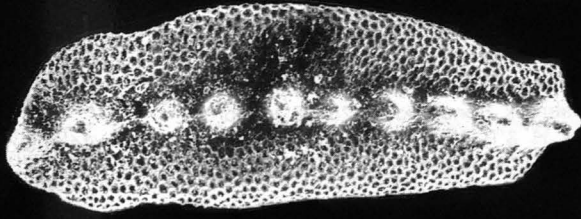
Rep.-no. CK 1988 VI-8, $\times 160$.

Fig. 6: *Pseudofurnishius murcianus* VAN DEN BOOGAARD.

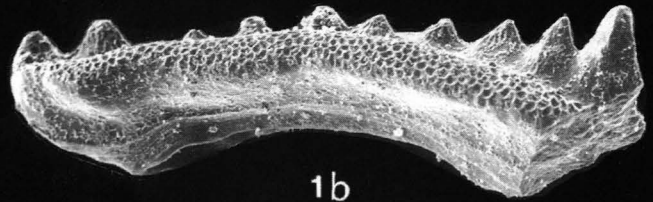
Rep.-no. CK 1988 VI-11, $\times 320$.

a) Oblique lateral view (anterior end obliquely upward tilted to show better the platform rudiment).

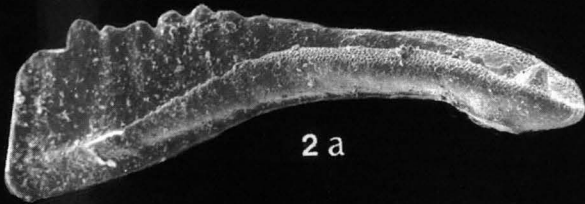
b) Upper view.



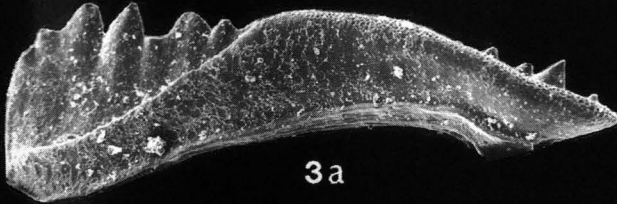
1a



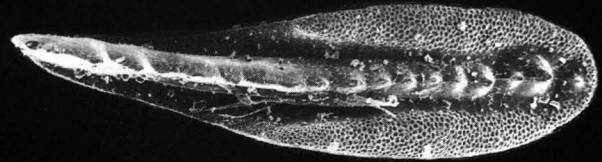
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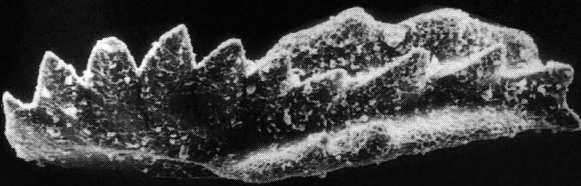
2a



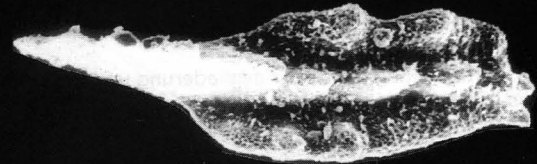
3a



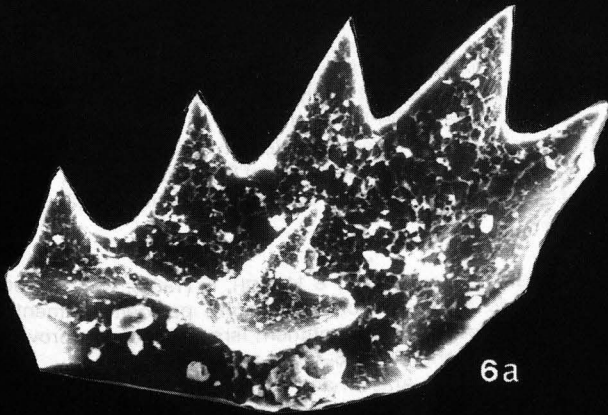
3b



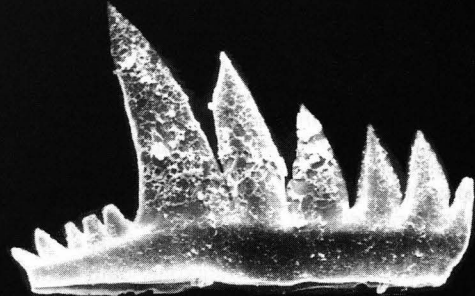
4a



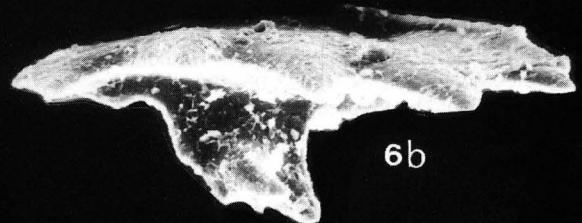
4b



6a



5



6b

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