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CONODONT STRATIGRAPHY, FACIES-RELATED DISTRIBUTION PATTERNS AND STABLE ISOTOPES (CARBON AND OXYGEN) OF THE UPPERMOST SILURIAN TO LOWER DEVONIAN SEEWARTE SECTION (CARNIC ALPS, CARINTHIA, AUSTRIA)

THOMAS JAMES SUTTNER

9 Text-Figures, 1 Table, 21 Plates

Geologische Bundesanstalt

Titelbild

Dünnschliff-Aufnahmen von Gesteinen des Seewarte-Profils.

Links: Rudstone der Hohe-Warte-Formation mit Grünalgen und Calcimikroben.
Mitte: Framestone der Hohe-Warte-Formation.
Rechts: Pa-Elemente von *Ozarkodina excavata excavata* in sparitischer Matrix (Megaerella-Formation).

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Conodont Stratigraphy, Facies-Related Distribution Patterns and Stable Isotopes (Carbon and Oxygen) of the Uppermost Silurian to Lower Devonian Seewarte Section (Carnic Alps, Carinthia, Austria)

THOMAS JAMES SUTTNER*)

9 Text-Figures, 1 Table, 21 Plates

On the occasion of his 65th birthday
this paper is kindly dedicated to Dr. H.P. SCHÖNLAUB
who has been the leading expert of the Carnic Alps for more than 30 years

Italien
Kärnten
Karnische Alpen
Paläozoikum
Silur
Devon
Megaerella-Formation
Rauchkofel-Formation
Hohe-Warte-Formation
Conodonten
Stabile Isotope

Österreichische Karte 1 : 50.000
Blatt 197

Inhalt

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Zusammenfassung

Die Pridoli-Pragium-Schichtfolge der Seewarte umfasst die Megaerella Formation (distale Schelfsedimente; nur die obersten 5 m aufgeschlossen), die Rauchkofel-Formation (neritische Fazies; 120 m) und die Hohe-Warte-Formation (Plattformsedimente; mindestens 200 m). Die laufenden Forschungen liefern neue Conodonten-Daten und ermöglichen eine präzisere zeitliche Einstufung dieser Formationen und damit Fortschritte gegenüber VAI (1973) und anderen Autoren.

Zahlreiche Conodonten wurden aus der Megaerella-Formation gewonnen; sie zeigen ein spätes Pridoli-Alter (z.B. *Belodella anomalis, Oulodus elegans detorta, Oulodus elegans elegans, Ozarkodina excavata excavata, Ozarkodina* aff. *O. remscheidensis eosteinhornensis, Ozarkodina remscheidensis remscheidensis*). Der untere Teil der Rauchkofel-Formation lieferte eine vielfältige Fauna der *delta*-Zone (z.B. *Ancyrodelloides kutscheri, Ancyrodelloides limbacarinatus, Ancyrodelloides transitans, Flajsella schulzei, Flajsella stygia, Lanea omoalpha, Lanea eoeleanorae* und *Lanea telleri*). Über dem letzten Vorkommen der typischen *delta*-Fauna wurden in einem schmalen Intervall M2-Elemente von *Pedavis* sp. entdeckt. Darüber folgt ein bemerkenswerter Megaklasten-Horizont, in dessen Matrix Elemente von *Latericriodus steinachensis* (beta- und eta-Morphotypen) die Basis des Pragium markieren. Die Anwendung der Standard-Conodontenzonierung auf die flachmarinen und Plattform-Lebensräume der Hohe-Warte-Formation (Pragium) war mit Schwierigkeiten verbunden. Obwohl in den Conodontenfaunen Pa-Elemente von *Eognathodus* fehlen, unterstützt der Nachweis von *Latericriodus steinachensis, Pelekysgnathus* sp. und *Caudicriodus* aff. *C. celtibericus* die alternative Zonengliederung des Pragium von SLAVÍK (2004b). Zusätzliche vereinzelte Spathognathodontiden wie *Ozarkodina remscheidensis repetitor, Pandorinellina* cf. *Pand. ebzeryi, Pandorinellina miae, Pandorinellina optima optima* und konische Elemente (*Coelocerodontus* cf. *C. reduncus, Decoriconus fragilis, Neopanderodus aequabilis, Neopanderodus leptostriatus*) wurden identifiziert. Die gefundenen Conodonten-Elemente zeigen einen CAI (color alteration index) von 3.

Zusätzliche Analysen von stabilen Isotopen, wie sie hauptsächlich als Werkzeug zur stratigraphischen Korrelation verwendet werden, zeigen einen positiven Trend quer über die vorgeschlagene Silur/Devon-Grenze. Eine starke Abweichung, wie sie aus anderen Profilen der Karnischen Alpen und dem Prager Becken bekannt ist, zeigt, dass das Intervall der *woschmidti*-Zone fehlt oder noch nicht identifiziert ist. Plötzlich ansteigende Werte an der Basis des Megaklasten-Horizonts korrelieren mit dem Erstauftreten von *Latericriodus* cf. *L. steinachensis* beta morph und zeigen die Basis des Pragium an. Anschließende Fazies-Analysen zeigen Muster von Häufungsverteilungen isolierter Conodonten-Elemente in Flachwasser-Lebensräumen.

Abstract

The Pridolian to Pragian succession of Mount Seewarte includes the Megaerella Formation (distal shelf sediments; only uppermost 5 m exposed), the Rauchkofel Formation (neritic facies; 120 m) and the Hohe Warte Formation (platform sediments; at least 200 m). The present investigations provide new conodont data enabling more precise time-allocation of these formations then suggested by VAI (1973) and other authors.

Abundant conodonts were obtained from the Megaerella Formation indicating a late Pridolian age (e.g.: *Belodella anomalis, Oulodus elegans detorta, Oulodus elegans elegans, Ozarkodina excavata excavata, Ozarkodina* aff. *O. remscheidensis eosteinhornensis, Ozarkodina remscheidensis remscheidensis*). The lower part of the Rauchkofel Formation produced a diverse fauna referred to the *delta* Zone (e.g.: *Ancyrodelloides kutscheri, Ancyrodelloides limbacarinatus, Ancyrodelloides transitans, Flajsella schulzei, Flajsella stygia, Lanea omoalpha, Lanea eoeleanorae* and *Lanea telleri*). Above the last occurrence of the typical *delta* fauna, M2 elements of *Pedavis* sp. were discovered within a narrow interval. It is succeeded by a remarkable megaclast horizon the matrix of which yields elements of *Latericriodus steinachensis* (assigned to both beta and eta morphotypes) indicating the base of the Pragian. Difficulties were experienced in applying the standard conodont zonation to the shallow marine and platform environments of the Pragian Hohe Warte Formation. Though the conodont assemblages lack Pa elements of *Eognathodus*, the record of *Latericriodus steinachensis, Pelekysgnathus* sp. and *Caudicriodus* aff. *C. celtibericus* supports the alternative zonation for the Pragian Stage suggested by SLAVÍK (2004b). Additional sparsely distributed spathognathodontids such as *Ozarkodina remscheidensis repetitor, Pandorinellina* cf. *Pand. ebzeryi, Pandorinellina miae, Pandorinellina optima optima* and simple cones (*Coelocerodontus* cf. *C. reduncus, Decoriconus fragilis, Neopanderodus aequabilis, Neopanderodus leptostriatus*) were identified. The color alteration index of the obtained conodont elements indicates a CAI of 3.

Additional analyses of stable isotopes, mainly used as tool for stratigraphical correlation, show a positive trend across the suggested Silurian-Devonian boundary. A strong excursion known from other sections of the Carnic Alps and the Prague Syncline suggests that the equivalent interval assigned to the *woschmidti* Zone is missing or yet not identified. A positive shift of suddenly increased values at the base of the megaclast horizon correlates with the first occurrence of *Latericriodus* cf. *L. steinachensis* beta morph, indicating the base of the Pragian Stage. Subsequent facial analyses provide data supporting patterns of accumulative distribution of isolated conodont elements in shallow water environments.

1. Introduction

1.1. Historical Overview

Early reports on the geology of the Carnic Alps, as well as the first excursion guides and maps of that region can be found in FRECH (1894), GEYER (1894 and 1903), TARAMELLI (1895) and other contributions written for the Geological Survey of Austria and Italy.

Their observations provided the framework for subsequent generations of geologists and palaeontologists working on Southern Alpine units. Numerous papers were produced in the past thirty years on Palaeozoic strata of the Kellerwand, Cellon, Rauchkofel, Bischofalm and Feldkogel nappes (e.g.: SCHÖNLAUB, 1970; FLÜGEL et al., 1977; SCHÖNLAUB, 1985a; KREUTZER et al., 1997; SCHÖNLAUB et al., 1997; FERRETTI et al., 1999; SCHÖNLAUB et al., 2004). Some workers specialized on conodonts described several new species especially from the Silurian and Devonian sections (WALLISER, 1964; PÖLSLER, 1969b; SCHÖNLAUB et al., 1980b; SCHÖNLAUB, 1985b). Collected conodont material and additional investigations on other fossil groups of specific lower Palaeozoic strata (graptolites, cephalopods and palynomorphs) provided an enormous dataset for high-resolution stratigraphy (PÖLSLER, 1969a; PRIEWALDER, 1987; PRIEWALDER, 1997; HISTON et al., 1999). Regarding the microfacial content and development of the shallow water deposits of Mount Seewarte, special attention is drawn to publications by VAI (1967), BANDEL (1969), KODSI (1971) and KREUTZER (1990).

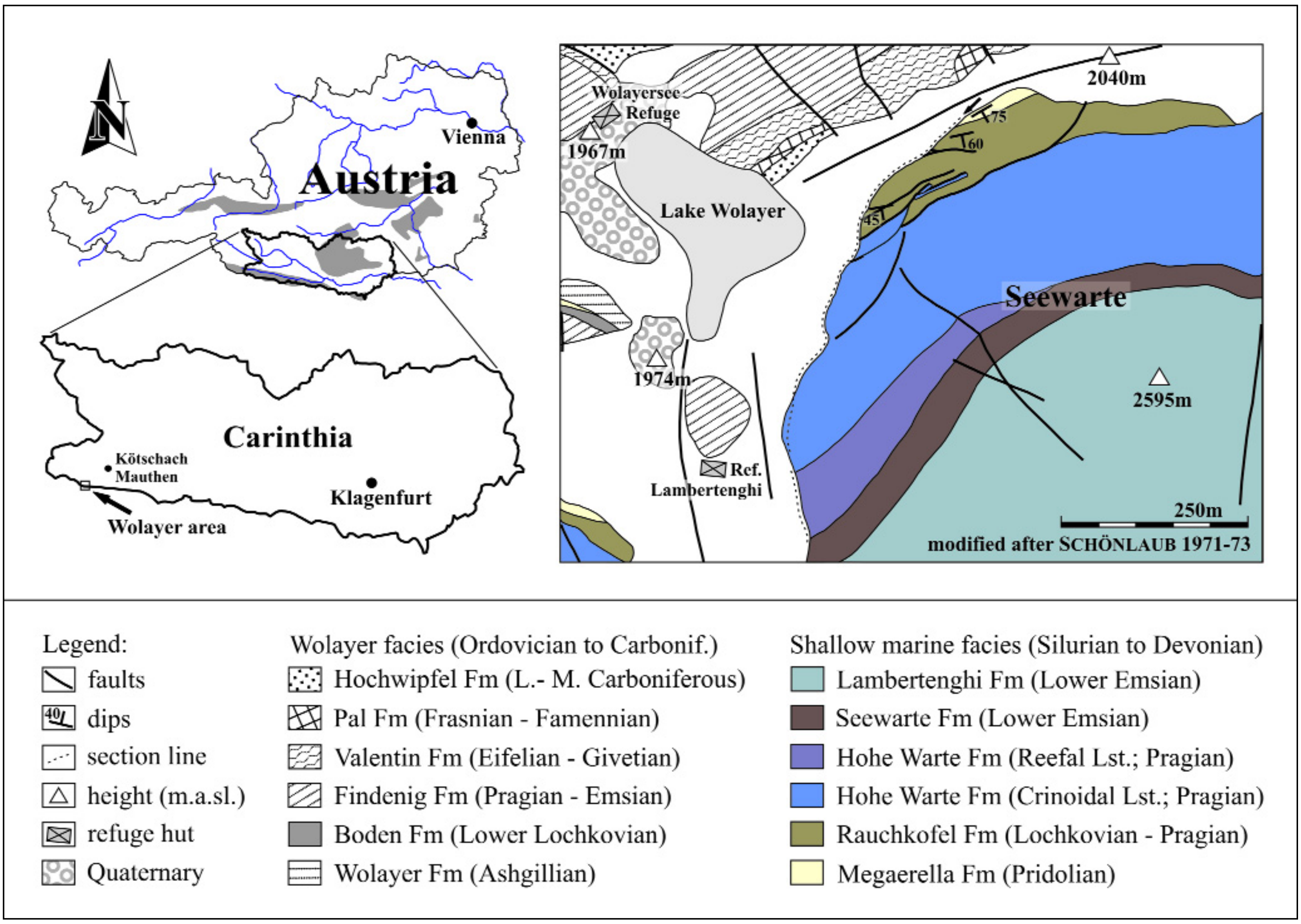
Based on the general development of the marine succession of the Kellerwand and Cellon nappes (Ordovician–Carboniferous) extensive collections were used successfully by KREUTZER (1992b) and presented in a photoatlas of the Variscan carbonate sequences. Somewhat less successful biostratigraphic studies along the northwestern footwall of the Seewarte were undertaken by VAI (1973) and others, compiled by SCHÖNLAUB & KREUTZER (1997). Palaeoenvironmental and bathymetric reconstructions based on the evaluation of the fossil record and the interpretation of geochemical data were provided by POHLER (1982) and by SCHÖNLAUB et al. (1994) and BUGGISCH & MANN (2004).

Furthermore, palinspastic reconstructions and the interpretation of palaeomagnetic and climate-sensitive data were used as helpful tools for specifying palaeogeographic relationships and settings of the Proto-Alps (SCHÖNLAUB, 1979; SCOTESE et al., 1979; SCOTESE & MCKERROW, 1990; STAMPFLI et al., 1991; KREUTZER, 1992a; SCHÖNLAUB, 1992; KREUTZER et al., 1997; SCHÖNLAUB & HISTON, 1999; STAMPFLI & BOREL, 2002).

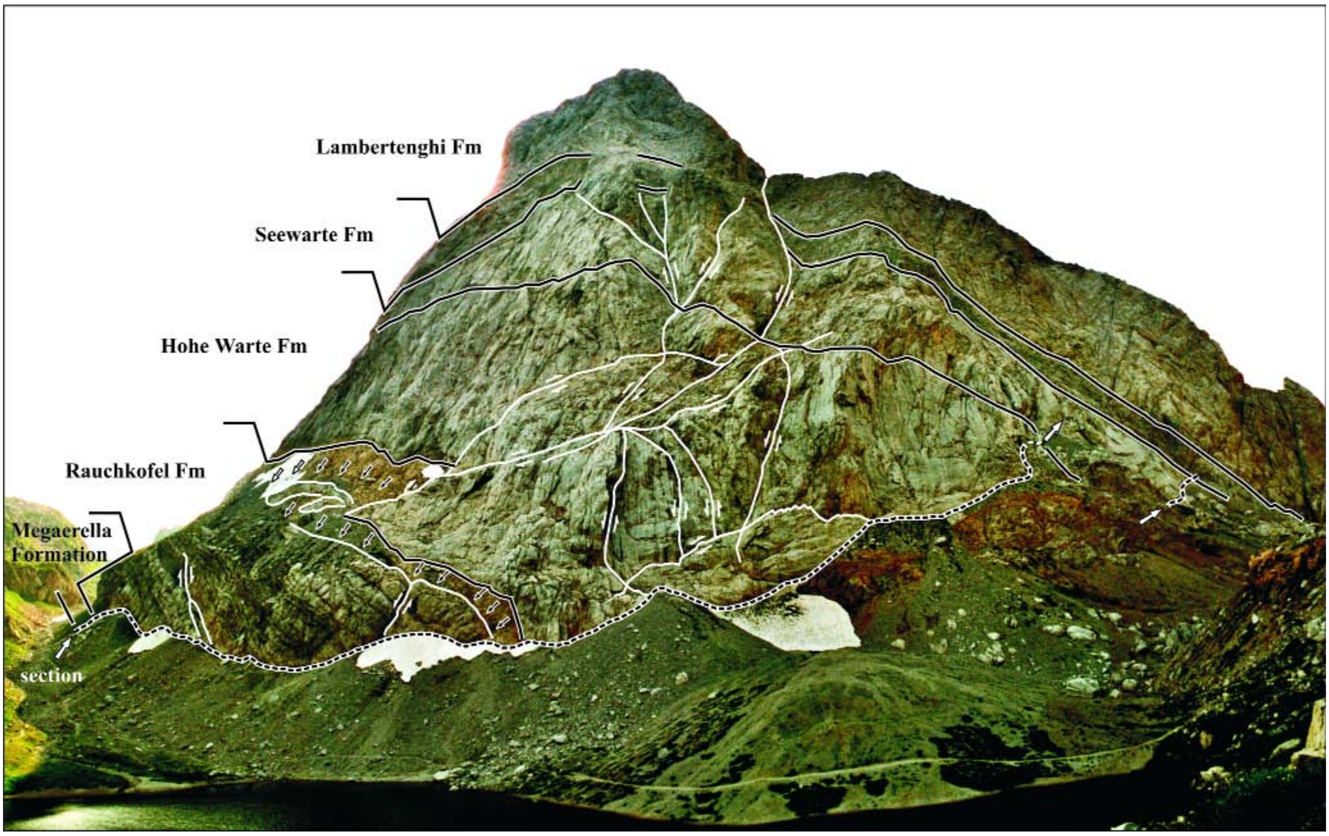
Due to these extensive investigations of the Palaeozoic sequence of the Carnic Alps, a guided geo-trail through the Carnic Alps (SCHÖNLAUB, 1991) was established by the Geological Survey of Austria and became operative in the late 1980s. Today it is an attraction for all kinds of tourists and mandatory for annual student trips and congress excursions emphasising geoscience.

1.2. Tasks and Targets

The research focused on providing new conodont data for the neritic Lower Devonian of the Carnic Alps and obtaining more precision as to the intervals of time represented by the investigated formations. The cumulative frequency of conodont assemblages is related to dominating microfacies types, assuming that the abundance and distribution of types of isolated elements is related to depositional environments – i.e. if controlled by taphonomy or not. Depositional patterns are discussed to probe the possibility of discriminating microfacies types within carbonates of neritic environments, based on a significant number of conodont elements obtained by precise sampling. Additionally carbon and oxygen isotopes are presented in support of the biostratigraphic data and provide further information on the palaeoecological bias through the Lower Devonian succession. Finally the section is compared to regional and trans-regional sequences for stratigraphic correlation and attempting to trace early Devonian crises and their impact on neritic deposition.



Text-Fig. 1.
The image to the left displays the distribution of Palaeozoic sediments of Austria (in grey). The map to the right represents local geological settings (modified from SCHÖNLAUB, 1971–73) of the working area at Lake Wolayer.
The dotted line marks the path along the investigated section of the northwestern exposures of Mount Seewarte.

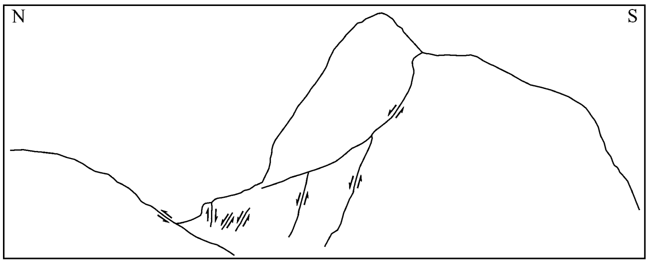


Text-Fig. 2.
Panorama of Mount Seewarte indicating the track along the northwestern footwall, as well as all formations represented and important faults.

2. Geography and Regional Geology

The Wolayer area (Text-Fig. 1) of the central Carnic Alps (Carinthia) exposes a complex series of Palaeozoic rocks. Mountains of the local Alpine scenery attributed to the Kellerwand Nappe have altitudes ranging between 2500 and 2800 m. The investigated section is located close to the lake running along the northern footwall of Mount Seewarte (2595 m) at a height of about 2000 m. The outcropping area can be reached either from the Austrian or the Italian side. Coming from Kötschach-Mauthen and Nostra the first track starts at the small Hubertus Chapel. At least two and a half hours have to be taken before reaching the Wolayersee Refuge, ascending gently over serpentines of a private forest-route, whereas the Italian track, starting near the village of Collina leads across a little cliffy, but more direct trail to the Lambertenghi Refuge on the opposite side of Lake Wolayer.

The Upper Silurian and Lower Devonian succession of Mount Seewarte is divided into five lithostratigraphical units (Megaerella Fm, Rauchkofel Fm, Hohe Warte Fm, Seewarte Fm and Lambertenghi Fm). Each formation indicated on Text-Fig. 2 has a very characteristic lithology and can be discriminated easily in field.



Text-Fig. 3.
Silhouette of the N–S transect displaying the faults of Mount Seewarte.

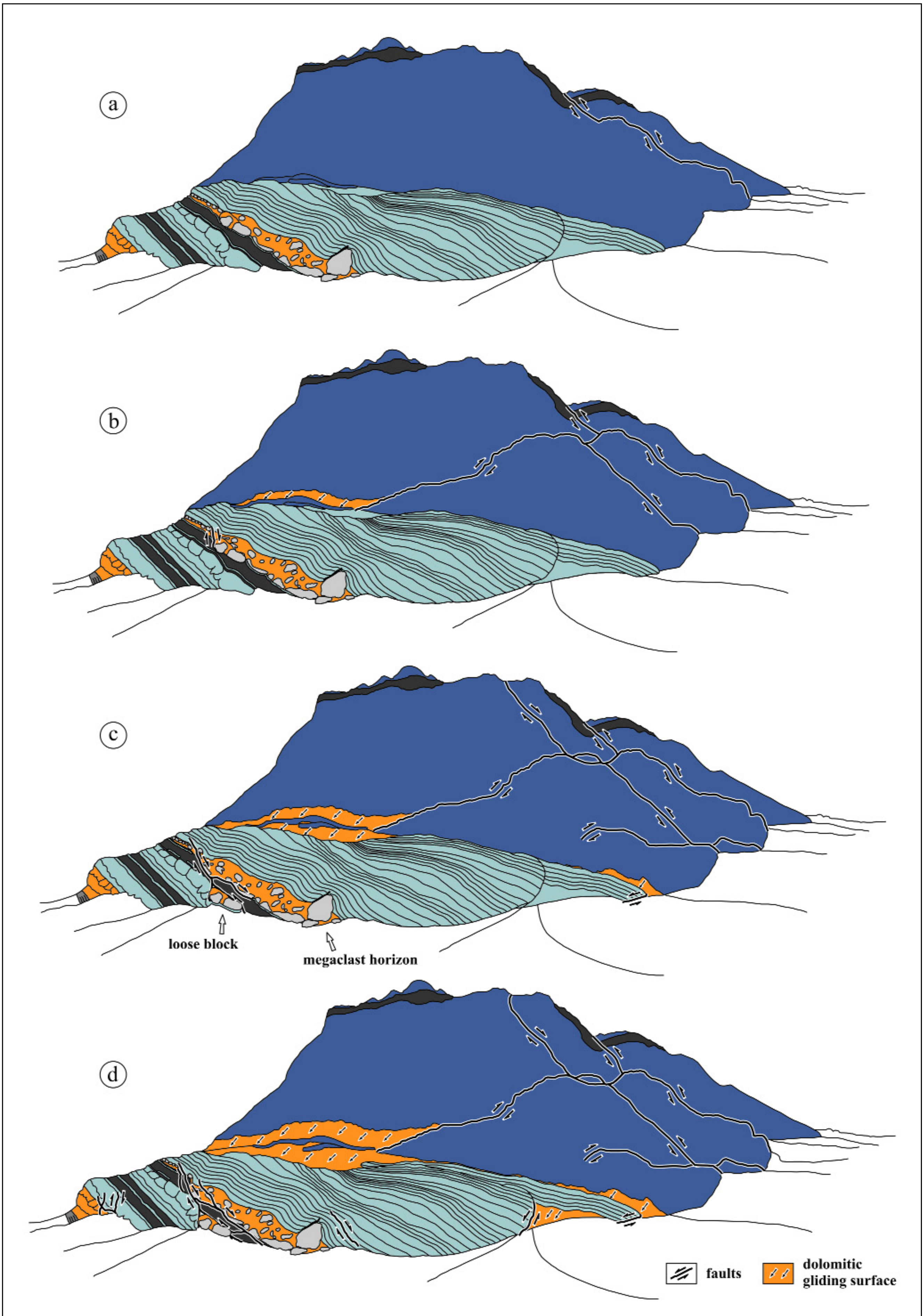
The uncovered uppermost part of the Megaerella Formation exposes grey, well bedded limestones. The Rauchkofel Formation (about 120 m) includes light and dark grey intervals of well bedded carbonates differing in thickness. Impressive megaclasts occur within an orange colored, dolomitic horizon at about mid height in the unit. The overlying Hohe Warte Formation consists of at least 200 m of bluish grey, massive limestone. It was divided into two subsequent units (Crinoidal Limestone and Reefal Limestone) by BANDEL (1969) and SCHÖNLAUB (1971–73). The succeeding Seewarte Formation exhibits about 40 m of thin bedded, bituminous dark grey limestones. Carbonates referred to the Lambertenghi Formation (about 150 m) consist mainly of cryptalgal laminates and bear oncolites and birdseyes, which represent peritidal deposits.

3. Local Tectonic Model

The lithological log of POHLER (1982), drawn in the course of her thesis, formed a helpful base during fieldwork and has been adopted with minor corrections and supplemented by additional information. As most of the corrections made concern local faulting across the section, a fault-model is proposed to support recent changes regarding the thickness of lithologic units. Observed faults of Mount Seewarte are indicated in Text-Fig. 3.

The following sketch (Text-Fig. 4) is based on field observations. First, the lower megaclast horizon (Text-Fig. 4c: “loose block”), is as illustrated in SCHÖNLAUB et al. (2004, p. 13, interpretation by C. BRETT). The second is the development of the local dolomitic area below the base of

Text-Fig. 4. ►▷►
Hypothesis of development of the fault and shear system, important for the sedimentary succession and especially for the conclusion that there was only one megaclast horizon.


a
b
c
loose block
megaclast horizon
d
faults
dolomitic gliding surface

the massive limestone. Three major steps from the original (Text-Fig. 4a) to the recent situation (Text-Fig. 4d) have been deciphered.

For the lower megaclast horizon, no lateral continuity was traceable over more than a few metres. Closer investigation has shown, that a large block from the megaclast horizon above glided off (compare Text-Fig. 4b–c). It was not easy to visualize at first glance, as the upper surface of that block lies in continuity with the in situ limestone beds running eastward.

4. Lithological Succession and Biostratigraphy

4.1. Megaerella Formation

Pridoli Series

Beds referred to the Megaerella Formation are confined to the very base of the sampled section. The uncovered accessible uppermost part of the formation measures only 5 m (Appendix 1, Fig. A; formation boundary marked by dotted line). Carbonates consisting of grey wacke-packstones include interbeds of few centimetre-thick layers of densely packed bioclastic grainstones. Common fossils were fragmented crinoids, bryozoans, brachiopods, corals and cephalopods (restricted to this interval). Conodont assemblages obtained consist of *Belodella anomalis, Dvorakia* aff. *D. chattertoni, Icriodus* sp., *Oulodus elegans detorta, Oulodus elegans elegans, Ozarkodina excavata excavata, Ozarkodina* aff. *O. remscheidensis eosteinhornensis, Ozarkodina remscheidensis remscheidensis, Panderodus unicostatus* and *Walliserodus multistriatus*. The first five samples produced several elements of *Belodella anomalis*, which not apparently do cross the Silurian/Devonian boundary. Because of the distinctive conodont fauna between samples Se/01/01/04 and Se/01/05/04 strata of the Megaerella Fm are attributed to the *detorta* Zone. The boundary with the Rauchkofel Formation is placed within the upper surface of a limestone bed, from whence came sample Se/01/05/04.

4.2. Rauchkofel Formation

Lochkovian Stage

The lowest part of the Rauchkofel Formation (Appendix 1, Figs. A, B) suffers from partial to strong dolomitization. The identification of lower Lochkovian conodont biozones, especially the *woschmidti* Zone seems exceedingly difficult. In fact, no distinctive I elements of *Icriodus woschmidti* were obtained. The first occurrence of *Lanea omoalpha* in sample Se/01/07/04 supports an age not older than the lower *delta* Zone. A typical mid-Lochkovian fauna, including species of *Ancyrodelloides, Flajsella, Lanea* and *Pandorinellina*, ranges up to sample Se/02/06a/05 (Appendix 1, Figs. C, D). Stratigraphical higher samples lack species of *Ancyrodelloides* and *Lanea*. The succeeding dark grey interval, yielding specimens assigned to *Pedavis* sp. (Se/02/08/04 to Se/02/13/04), is attributed to the *pesavis* Zone and thus to the upper Lochkovian. The boundary between the *delta* and *pesavis* Zone is assumed between samples Se/02/07/04 and Se/02/08/04.

Pragian Stage

The base of the megaclast horizon is regarded to indicate the base of the Pragian Stage. Single limestone clasts within the matrix-supported horizon reach sizes 2 to 10 m in diameter. Beds succeeding and finally covering the largest clast observed (Appendix 1, Fig. E, lower right corner), of which nearly half is protruding out of the matrix, accord with an approximately west–east transport direction. Evidence that beds to the left of the clast were deposited horizontally accords with it having been the protected lee side. However, beds to the right, more angular margin of the clast are ramp-like, suggesting exposure to submarine currents. Tracing the lateral continuity of the megaclast horizon shows that it decreases in thickness and finally disappears somewhat farther east (Appendix 1, Fig. E; Appendix 2). Also the succession to the East lacks the conspicuous dark grey interval (attributed to the *pesavis* Zone) below the megaclast horizon.

Rock samples of two megaclasts (indicated in grey in Appendix 6) were cut for microfacial analyses and for age assignment. Unfortunately, both samples produced only a few conodonts of little stratigraphic consequence. According to the thin sections, the clasts are massive limestones consisting of reefal debris. Better results came from conodont samples from the dolomitic matrix of the megaclast horizon (Se/02/15/04 to Se/02/15c/05); they produced I elements of *Latericriodus steinachensis* eta morph and one, but broken, *Latericriodus* cf. *L. steinachensis* beta morph (Se/02/15b/05). While the first icriodontid species is reported to occur in the late *delta* Zone, the appearance of the latter morphotype is restricted to the Pragian Stage. Considering this, the Lochkovian/Pragian boundary is drawn at the base of the megaclast horizon between samples Se/02/14/04 and Se/02/15b/04 (Appendix 1, Fig. F).

The subsequent well-bedded limestones consisting of peloidal pack- to grainstones, pure crinoidal grainstones and rudstones form a few thickening-upward cycles. Though these beds generally yield few conodonts, the *Latericriodus steinachensis* eta morph occurs in some of them, confirming a lower Pragian age for the entire upper part of the Rauchkofel Formation. Other conodonts obtained are assigned to *Ozarkodina pandora, Pandorinellina* sp. and simple cones of long-ranging species. No Pa element of any *Eognathodus* was obtained; hence the standard conodont zonation across the Rauchkofel Formation is inferred from the alternative zonation proposed by SLAVÍK (2004b).

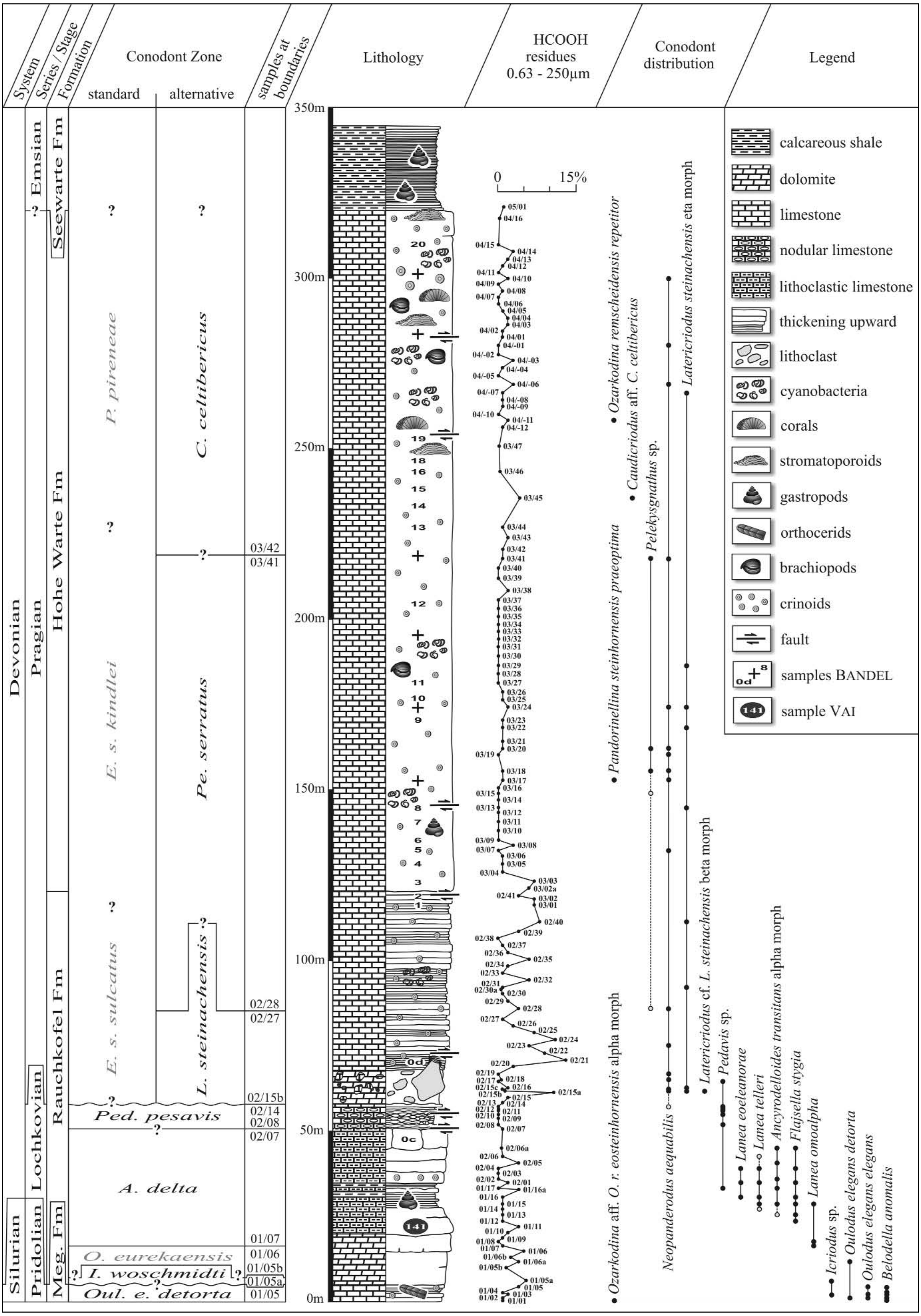
4.3. Hohe Warte Formation

Pragian Stage

The entire formation consists of massive limestone, appearing rather uniform facially from a distance, but closer study indicates a microfacies spectrum of varying depositional environments. The lower two-thirds generally comprise crinoidal pack- and grainstones alternating with intervals of reefal debris. The first small patch reefs appear near the middle part, becoming most abundant in the upper part; they consist of tabulate corals, stromatoporoids and calcimicrobes. Intervening, rudstones consist of densely packed remains of dasyclad green algae from back reef environments and accumulated lenses of brachiopods. The transition to lagoonal deposits of the Seewarte Formation is more or less gradual by increasing proportion of organic matter in a short interval at the formation boundary.

The Hohe Warte Formation is assumed to be Pragian. VAI in SCHÖNLAUB (ed., 1980b, p. 32, Fig. 16, sample FV 136, therein) assigned specimens to *"Icriodus* cf. *huddlei curvi-*

Text-Fig. 5. ►▷►
A detailed log of the section at Mount Seewarte implying data on stratigraphy and lithology of the sampled formations: Megaerella Fm (Pridolian), Rauchkofel Fm (Lochkovian to Pragian) and Hohe Warte Fm (Pragian). Conodont zones in grey lack distinctive conodonts for being verified as such. In the log included are numbers of former sampling campaigns by BANDEL (1969): numbers 0c to 20 and VAI (1967): number 141. Relative rates of insoluble residues show the clastic input of sediment between 0.63–250 µm grain size among the entire section. The occurrence of conodont taxa, most suggestive for fixing biostratigraphic boundaries, is indicated by black dots (taxa of uncertain assignment are represented by grey dots).



System
Series / Stage
Formation
Conodont Zone
standard
alternative
samples at boundaries
Lithology
HCOOH residues 0.63 - 250µm
Conodont distribution
Legend
Silurian
Devonian
Pridolian
Lochkovian
Pragian
Emsian
Meg. Fm
Rauchkofel Fm
Hohe Warte Fm
Seewarte Fm
Oul. e. detorta
I. woschmidti
O. eurekaensis
A. delta
Ped. pesavis
E. s. sulcatus
E. s. kindlei
P. pireneae
L. steinachensis
Pe. serratus
C. celtibericus
350m
300m
250m
200m
150m
100m
50m
0m
0
15%
Ozarkodina aff. O. r. eosteinhornensis alpha morph
Pandorinellina steinhornensis praeoptima
Ozarkodina remscheidensis repetitor
Caudicriodus aff. C. celtibericus
Pelekysgnathus sp.
Neopanderodus aequabilis
Latericriodus steinachensis eta morph
Latericriodus cf. L. steinachensis beta morph
Pedavis sp.
Lanea eoeleanorae
Lanea telleri
Ancyrodelloides transitans alpha morph
Flajsella stygia
Lanea omoalpha
Icriodus sp.
Oulodus elegans detorta
Oulodus elegans elegans
Belodella anomalis
calcareous shale
dolomite
limestone
nodular limestone
lithoclastic limestone
thickening upward
lithoclast
cyanobacteria
corals
stromatoporoids
gastropods
orthocerids
brachiopods
crinoids
fault
samples BANDEL
sample VAI

cauda" from somewhere possibly close to the present sampling campaign number Se/03/37/04 (Text-Fig. 5). I elements referred to *Caudicriodus* sp. (lacking distinct features for assigning them to *Caudicriodus curvicauda*) were obtained in the same interval. Thus the boundaries of the *serratus* Zone (SLAVÍK, 2004b: 62) accord with the first and last occurrence of taxa belonging to the *Pelekysgnathus serratus* group, the *serratus* Zone is proposed to range from sample Se/02/28/04 to Se/03/41/04. The single occurrence of a partially fragmented I element of *Caudicriodus* aff. *C. celtibericus* in sample Se/03/45/05 (Appendix 1, Fig. G) is assumed to indicate the lower part of the *celtibericus* Zone. Other conodonts obtained among the massive limestones are *Belodella striata, Coelocerodontus* cf. *C. reduncus, Dvorakia klapperi, Neopanderodus aequabilis, Neopanderodus leptostriatus, Ozarkodina remscheidensis repetitor, Pandorinellina miae, Pandorinellina steinhornensis praeoptima* and specimens of *Pelekysgnathus*. Conodont samples close to the boundary of the Hohe Warte Formation with the Seewarte Formation produced no or only a few specimens of *Belodella resima, Dvorakia klapperi* and *Panderodus*. No platform elements were obtained to assign the carbonate beds to a proper biostratigraphic level (Appendix 1, Fig. H; formation boundary marked by dotted line). Thus, an age not younger than upper Pragian is assumed for the top of the Hohe Warte Formation, but chronologically constraining conodonts are needed.

5. Facies Analysis

5.1. Microfacies

Rocks were classified according to the scheme of DUNHAM (1962), using the more specific determination of microfacies types (MF-type 1 to 10) advocated by KREUTZER (1990), who suggested use of additional types (and several sub-types) for facies analyses, lateral correlation and palaeoecologic interpretation of Devonian units through the Kellerwand to Cellon nappes of the central Carnic Alps. His concept is accepted here to facilitate correlation. The following types are present in the Seewarte section (see also BANDEL, 1969):

MF-type 2: Grainstone

Grainstones were found to range from bioclasts with little or no micritisation (Plate 1, Fig. 2) to coated grains wherein the rim is extensively micritized around the entire grain (Plate 1, Fig. 1). The first of these accords with rather rapid cementation of components after breakage and deposition. Components are crinoid stem plates with subordinate skeletal grains of brachiopods and bryozoans. Peloids are sparse or even lacking.

MF-type 3a: Peloidal pack- to grainstone

In some thin-sections the most of the clastic component are peloidal grains in sparitic matrix with subordinate larger skeletal components such as mollusc shells, bryozoans, crinoids, trilobites and brachiopod valves. Other limestone beds have less peloids, with bioclasts forming the major allochthonous components in predominantly sparitic rather than micritic matrix.

MF-type 5b: Framestone

Frame builders are tabulate corals, stromatoporoids, calcareous green algae and calcimicrobes. Organisms of the carbonate factory usually formed small patch reefs and biostromes. The major part of the Hohe Warte Formation consists of reefal debris fringing buildups. The frequency of patch reefs increases in the upper part of the massive limestone.

MF-type 5c: Bindstone

Some thin-sections show mixed facies classified as frame- to bindstones with microbial mats binding sediment particles between the coral and stromatoporoid colonies. True bindstones occur at the base of the Seewarte Formation. The limestones consist of thin-bedded fenestral mudstones. Common constituents are microbialites, ostracod valves, gastropods and peloids between spar-filled stromatactis.

MF-type 6: Rudstone, breccia of reefal debris

Components are tabulate corals, stromatoporoids, cyanobacteria mixed with organisms from fore- and backreef environments such as calcareous green algae (cf. HUBMANN, 1994), crinoids, and subordinate shell fragments of molluscs and brachiopods. Thin-sections show areas classified as wackestone or peloidal pack-/grainstone between reefal residues and other bioclasts.

MF-type 8?: Pelagic mudstone

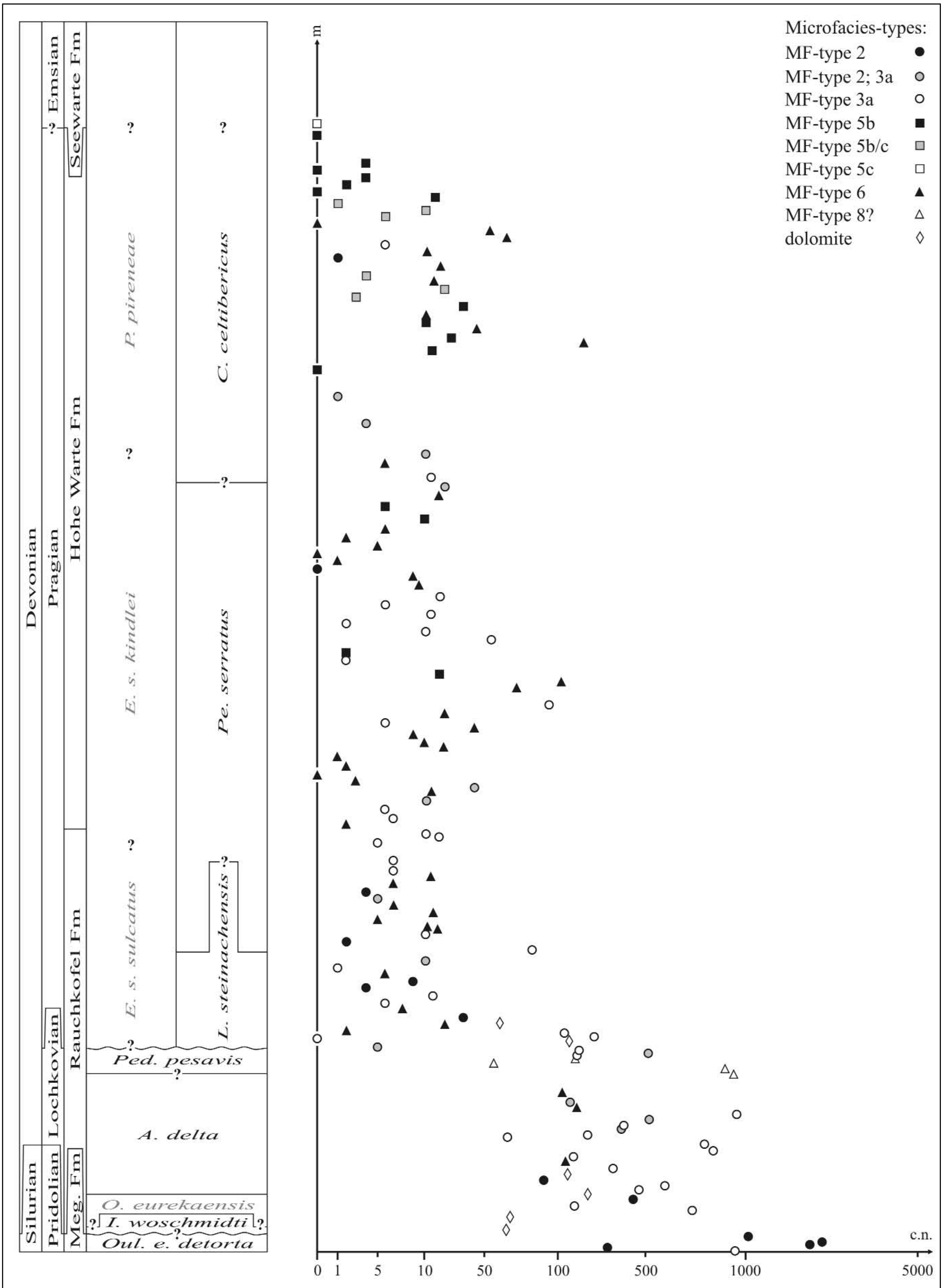
The interval assigned to microfacies type 8 of KREUTZER (1990) is followed by a question mark because the depositional environment of this part of the formation is interpreted as a transitional facies possibly located more distally on the shelf. None of the other proposed microfacies-types of KREUTZER (1990) and additional types 11–13 in KREUTZER (1992a) can be applied here. These limestones are bituminous, fine-grained, organodetritic carbonates with pyrite, small amounts of siliciclastics, peloids and comminuted or small biogenes (including small phosphatic brachiopods). The sediment is partly dolomitized with increase in fine dolomitic grains along stylolites.

General Remarks

Sediments are rich in carbonate throughout, consisting of up to 12.7 % of clastic insolubles between 0.63 and 250 μm (compare Text-Fig. 5). They are represented by siliciclastics, dolomite and a negligible amount of heavy mineral grains. Values of clastic components vary from the base of the section to the base of the megaclast horizon between 0.1 and 5.43 %. Some samples from the upper part of the Rauchkofel Formation have increased amounts of dolomitic grains from late diagenetic processes; they were obtained from limestone beds close to minor fault zones.

The first occurrence of single tubular microbial colonies such as *Girvanella* (Plate 1, Fig. H) were observed a few metres below the megaclast horizon (sample: Se/02/12/04). The first small aggregates of the *Renalcis* Group occur about 30 m above the megaclast horizon in samples Se/02/31/04 and Se/02/33/04, increasing in number in the lower third of the Hohe Warte Formation. The aggregates grow much larger becoming important constituents of the local frame-building guilds in the upper third of that massive limestone sequence. The first fragments of calcareous green algae occur 25 m above the base of the Hohe Warte Formation in sample Se/03/12/04. Deposits rich in calcareous algae occur in the uppermost quarter of the Hohe Warte Formation.

The insoluble clastic content through the unbedded limestones of the Hohe Warte Formation range from 0.1 to 6.7 %. Thin sections showing partial dolomitization with sparse to moderately distributed dolomite grains are indicated as "+ dolomite" in Appendix 6. Nearly totally recrystallized rocks were identified as dolomite. Where portions of non-diagenetic sediments were observed, the original microfacies-type is included (e.g.: "dolomite; prim: 3a" = primary microfacies-type 3a). Microfacies types occurring in the Seewarte section are shown on Plate 1 to 3 (for distribution compare Appendix 6).



Text-Fig. 6.
Absolute quantities of conodont elements (yield from dissolved rock samples) in relation to microfacies through the Seewarte section.
m = metres above base; c.n. = number of conodont elements.

5.2. Facies-Related Distribution Patterns of Conodont Elements

Modes of deposition differ from those of pelagic environments where conodonts are enriched in thin beds due to winnowing from the unconsolidated sediments. In contrast, conodont elements are not equally distributed through the shallow marine environments. The deposition and distribution is controlled mainly by current velocities and the character of the sea floor, whether planar or uneven, consisting of small dunes or submarine channels, or composed of bioconstructions. Differing hydrodynamics of individual conodonts – shape, centre of gravity, weight (MCGOFF, 1991) – and the grain size of the sediment containing the conodonts are all important. Biogenic structures such as load casts or layers of accumulated shells of macrofossils act as traps for all kinds of microfossil remains. Other members of the community (sessile or endolithic) are preserved mainly by becoming overgrown. The chance for vagile organisms or even their hard tissues being preserved in large numbers in such areas (especially biogenic buildups) is very low. Because of this, numbers of conodont specimens are plotted in relation to the predominant microfacies-types (Text-Fig. 6). The graph shows that elements are most abundant in peloidal pack- to grainstones (MF-type 3a) and pure crinoidal grainstones (MF-type 2), where two samples produced about 3000 elements. In contrast, rudstones (MF-type 6) yield up to 260 and framestones (MF-type 5b) below 40 conodont elements. No specimens were obtained from bindstones (MF-type 5c).

The abundance pattern of elements is still difficult to explain. Due to the evidence that the majority of the elements are allochthonous isolated remains rather than aligned clusters or natural assemblages, decisive factors for the limitation of elements are the taphonomic potential of the dominating microfacies. Considering that the biology and ecology of conodonts is still under discussion, reconstructions of their preliminary habitat, whether they preferred pelagic, benthic, or infaunal environments, is still very interpretative. One of the remaining questions concerning the distribution patterns of conodont elements and the taphonomic scenery behind is how far isolated conodont units of local populations were transported and where transport started related to the post- or even re-depositional record preserved. Biases according with the interpretation of the fossil record of conodonts are discussed under various aspects by PURNELL & DONOGHUE (2005).

6. Stable Isotopes

6.1. Carbon Isotopes

Carbon isotopes, starting at 1.33 per mil at the base of the section, have a slight positive shift, up to 2.02 per mil, from the *detorta* to the *eurekaensis*(?) Zones. Subsequent values across the *delta* and *pesavis* Zones range between 0.71 and 1.91 per mil. A sudden positive shift to 3.11 per mil occurs at the base of the megaclast horizon. From that sample on, values vary between 1.94 and 3.29 per mil. One limestone sample about 35 m above the base of the Hohe Warte Formation registered 1.35 per mil, presumably due to diagenetic alteration of micrite; the sample was obtained close to a minor fault in a small strongly dolomitized area. Bedded limestones from the uppermost part of the Rauchkofel Formation to the top of the massive limestone of the Hohe Warte Formation do not have values exceeding 3.00 per mil. The standard deviation (three measurements per sample) usually does not exceed 0.05 except for one sample (Se/02/07/04) with a standard deviation of 0.11.

Mean values and associated standard deviations for all measured samples are presented in Appendix 6. Plots of the stable isotope data are presented in relation to conodont biozones on Text-Fig. 7.

6.2. Oxygen Isotopes

Oxygen isotope data range between –9.26 and –1.61. Irregular excursions suggest oxidation of micrite in rock samples. A mean trend-line nevertheless follows the general curve of the carbon excursion. Standard deviations do not exceed 0.15. More reliable oxygen isotope values were obtained from unaltered, primary calcite of brachiopod shells or conodont apatite instead of micrite from whole-rock samples. Unfortunately, brachiopods are sparse through the entire Seewarte section, and some conodont assemblages had to be sacrificed. The weight of conodont material is indicated in Appendix 6. The results will be published separately with the Erlangen conodont-isotope-research team.

7. Material and Methods

140 conodont samples weighing between 0.6 and 6.5 kg (precise weights and distance between each sample is indicated in Appendix 6) were obtained from the Seewarte section (Wolayer area, Carnic Alps). Only 10 of them yielded no conodonts (Se/02/15a/05; Se/03/09/04; Se/03/32/04; Se/03/34/04; Se/03/47/05; Se/04/06/04; Se/04/11/04; Se/04/14/04; Se/04/16/05 and Se/05/01/05).

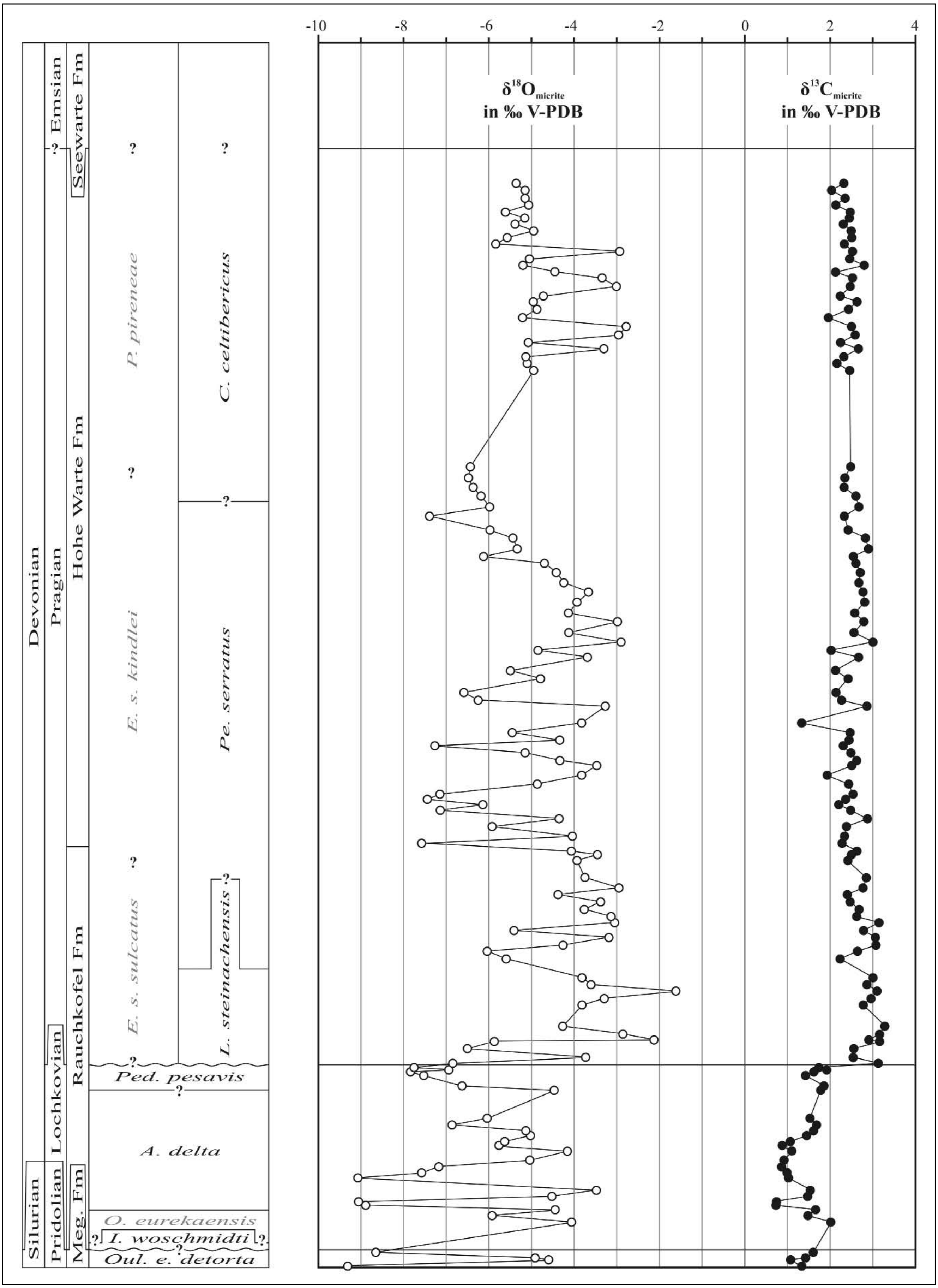
Every rock sample was crushed into small pieces of about 2 cm increasing the surface for subsequent acid-leaching. For dissolution, fractured rock pieces were put in coarse-meshed sieves hung in tubs filled with formic acid, using ratios of 1 unit of HCOOH (85 %) and 5 units of warmish water. The insoluble residues were separated into 3 fractions (0.63 µm, 125–250 µm and 500 µm). Further details on acid leaching techniques are presented in AUSTIN (1987) and JEPPSSON & ANEHUS (1995).

The amount of dried residues was measured to calculate the relative carbonate content of each sample. Usually the 125–250 µm fraction was used for segregating conodonts. Only where insoluble residues were obtained in very small amounts was the 0.63 µm fraction used. Immediately after drying residues of less than 5 g (and those of the 500 µm fraction) were scanned under a stereomicroscope for conodonts and other microfossils with a fine needle.

Residues of more than 5 g were treated with heavy liquid (1, 1, 2, 2-tetrabromethane 98 %) for separating heavy minerals from siliciclastic residues and enhancing the number of conodont elements before picking them. Alternative methods for heavy mineral separation are provided by KRUKOWSKI (1988) and SAVAGE (1988), which are recommended by the author.

In contrast to the highly carcinogenic and neurotoxic tetrabromethane the fluid (sodium metatungstate) used is nontoxic and resulted in only minor additional efforts in preparing it for separation. Conodont specimens figured on plates 4 to 21 were sputter-coated with a fine gold cover for 6–8 minutes and scanned in a JEOL JSM-6400 scanning microscope using 10 kV. Final images were manipulated in Photo Paint and Corel Draw.

The conodont color alteration index (CAI) of conodont assemblages was estimated using the color chart provided by EPSTEIN et al. (1977). Conodont elements of the Seewarte section indicate a CAI of 3. HELSEN et al. (1995) improved a technique for quantifying color alteration indices by using color image analysis; this was not used in this study. They demonstrate the relevance of the conodont color alteration index for geological research, since the method is uncomplicated and easy to handle.



Text-Fig. 7.
Stable isotope data ($\delta^{13}C$, $\delta^{18}O$) of micrite from whole rock samples.

Of each rock sample one thin section was prepared for microfacial analyses. The color of unweathered rock surfaces and insoluble residues was determined in conjunction with a standard rock-color chart (distributed by the Geological Society of America). Classification of rocks was based on the charts of DUNHAM (1962) and FOLK (1962). Palaeoenvironmental reconstructions and interpretation of calcareous rocks follow mainly criteria discussed in PAPP & TURNOVSKY (1970), ADAMS et al. (1986) and FLÜGEL (2004).

For stable isotopes ($\delta^{13}C$, $\delta^{18}O$), micrite of whole rocks was extracted by drilling small pieces with a vibro-tool. The powdered micrite was treated with phosphoric acid and analysed in a mass spectrometer. Obtained values are reported in per mil relative to the V-PDB standard.

Conodont samples are stored at the Geological Survey of Austria, Vienna (illustrated material: GBA-2006/1/14-31 = Geologische Bundesanstalt-year/current GBA number/SEM-table and table-position; additional material: GBA-2006/1/SE 039 = Geologische Bundesanstalt-year/current GBA number/current number of the SEewarte material). Thin sections and residual rock samples for further analyses are housed in the Institute of Palaeontology, University of Vienna, room 2B-191 (IPUW-3803-1-2, Institut für Paläontologie der Universität Wien-current IPUW number-unit-sample). Abbreviation of recent sampling campaign numbers: Se/01/01/04 = Seewarte section/unit/sample/year. Sample numbers on Text-Fig. 5 and Appendix 1 are reduced to their middle part (e.g.: Se/01/01/04 = 01/01).

8. Conodont Color Alteration Index

A representative assembly of conodonts was photographed under the stereomicroscope to define the distribution of white matter and color alteration of the conodont elements in general (Text-Fig. 8). Illustrated specimens of the *Ozarkodina excavata excavata* apparatus have milky opaque denticles. The lower area of the cusp and the entire blade from close to the base of the denticles to the basal margin ranges between brownish grey and brownish black. Thin-walled simple cones are milky white (lateral face, covering the triangular basal cavity) to light olive grey (anterior and posterior margin, tip of the cusp and posterior denticulation). Hence, a mean color alteration index (CAI) of 3 is inferred, assuming burial temperatures of less than 200°C for the observed strata.

9. Systematic Palaeontology

The systematic concept of conodont classification from the Order downward follows SWEET (1988). The assignment of Phylum to Class, still controversial, follows recent publications of SANSOM et al. (1992), JANVIER (1995), ALDRIDGE & PURNELL (1996), ZIEGLER & WEDDIGE (1999) and SWEET & DONOGHUE (2001). Characteristic features and descriptive terms used for determination are compiled in Appendix 3 and 4. All elements obtained are from the NW Seewarte section at Lake Wolayer (Mount Seewarte, Kellerwand Nappe, Carnic Alps, Carinthia, Austria). The distribution of conodonts (Megaerella Fm, Rauchkofel Fm and Hohe Warte Fm) is indicated in Appendix 5.

Conventions and Abbreviations:

Page numbers in synonymies indicate where the taxonomic description of a species starts. If no separate taxonomic division exists, page numbers indicate where additional remarks occur in the text.

aff. (affinis); cf. (confer); fig. (figure); n. sp. (nova species); p. (page); pl. (plate); sp. (species); tab. (table); conodont genera: *A. = Ancyrodelloides; B. = Belodella; C. = Caudicriodus; E. = Eognathodus; F. = Flajsella; I. = Icriodus; L. = Lanea; L. = Latericriodus; Oul. = Oulodus; O. = Ozarkodina; Pand. = Pandorinellina; Ped. = Pedavis; Pe. = Pelekysgnathus; P. = Polygnathus.*

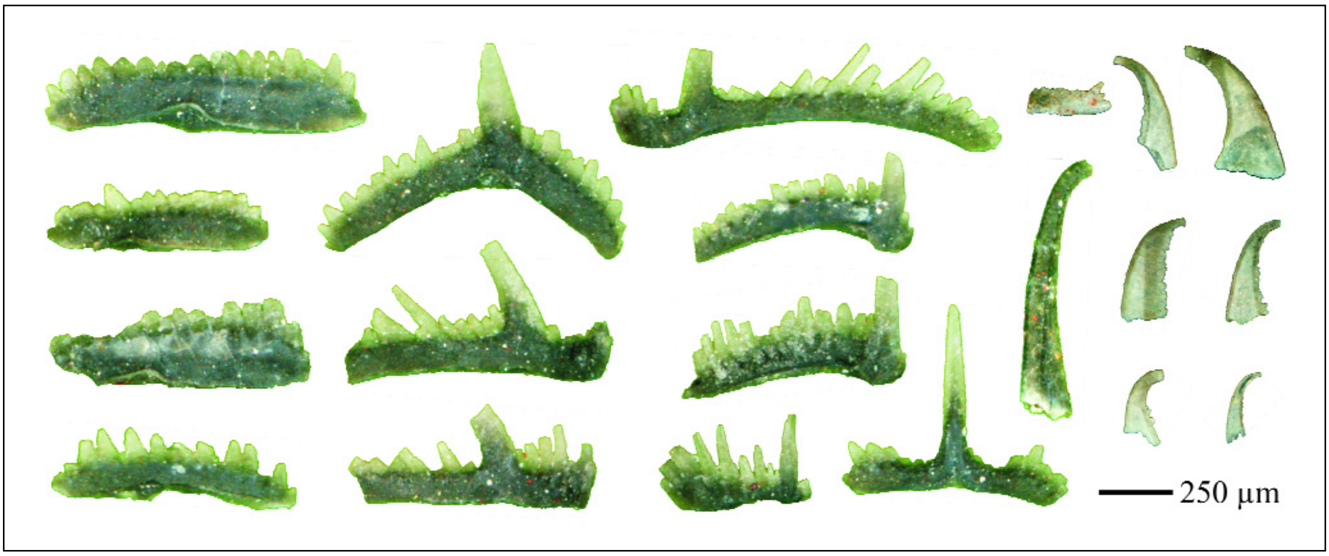
Phylum: Chordata BATESON, 1886
Subphylum: Vertebrata LAMARCK, 1801
Class: Conodonta EICHENBERG, 1930 sensu CLARK, 1981
Order: Belodellida SWEET, 1988
Family: Belodellidae KHODALEVICH & TSCHERNICH, 1973
Genus: *Belodella* ETHINGTON, 1959

Type species: *Belodus devonicus* STAUFFER, 1940.

Belodella anomalis COOPER, 1974

Pl. 4; Figs. 1–6

General Remarks: The multimembrate apparatus features elements with characteristic denticulation along the anterior (to anterio-lateral) margin(s), which separates



Text-Fig. 8.
Stereomicroscopic images (left to right) of 4 Pa, 1 Pb, 3 Sc, 2 M and 2 Sa elements of *Ozarkodina excavata excavata* (Se/01/04/04), 1 element of *Panderodus* sp. (Se/01/04/04), 1 Sa element of *Ozarkodina* sp. (Se/04/-04/04) and 6 elements of *Belodella* sp. (Se/04/-04/04) indicating a CAI of 3.

Belodella anomalis from all other belodellid species. Lateral denticulation within the upper part of the cusp forms a fan-like structure in Sa, Sb and Sc elements only. Sd and T elements lack the distal fanning and have a free-ending, pointed cusp instead. The scheme in FARRELL, 2004 (Text-Fig. 4, therein) readily distinguishing elements from each other. It shows, that the apparatus includes element types possessing triangular, compressed triangular and lenticular cross-sections, which is relevant for reconstruction of other belodellid apparatuses. ANDERSSON, 2003 (Fig. 2, therein) presented an overview regarding the distribution and range of five species of *Belodella* occurring in Upper Silurian to Middle Devonian strata in eastern Australia. A maximum range for *Belodella anomalis* from the *siluricus* Zone (Ludlow) to the uppermost *detorta* Zone (Pridoli), not crossing the Silurian-Devonian boundary, was suggested. A similar age and range was concluded for European specimens by JEPPSSON (1989). He reported *Belodella anomalis* up to few centimetres below the Silurian-Devonian boundary in bed 19 at Klonk (Czech Republic).

Material: 162 specimens.

Sa element (Pl. 4, Fig. 5)

1989 *Belodella anomalis* COOPER – JEPPSSON, p. 25; Pl. 1, Fig. 15.
1998 *Belodella anomalis* COOPER – SERPAGLI, CORRADINI & FERRETTI, Pl. 1.2.2, Fig. 8.
2003 *Belodella anomalis* COOPER – ANDERSON, p. 472; Pl. 3, Fig. 26.
2004 *Belodella anomalis* COOPER – FARRELL, p. 947; Pl. 1, Fig. 17; Text-Fig. 4.

Description: The Sa element has a deep basal cavity, triangular in cross-section, with a broad anterior margin. Either anterior margin is denticulate with fine aligned denticles starting near the lower margin. Denticles along the posterior margin form a straight line. Those of the anterior margin develop a symmetrical fan-like structure on either side of the apex (fragmented in the figured specimen). Usually the fan consists of denticles from just beneath the tip, aligned with the apex laterally, constituting the typical T-shape of the element in posterior view. The outline of the element is triangular in lateral view with lateral faces remaining unornamented.

Sb element (Pl. 4, Fig. 6)

1974 *Belodella anomalis* COOPER, p. 1121; Pl. 1, Figs. 7–10; Text-Figs. 1c–d.
1995 *Belodella anomalis* COOPER – SIMPSON & TALENT, p. 124; Pl. 4, Figs. 1–3.
1999 *Belodella anomalis* COOPER – COCKLE, p. 118; Pl. 4, Figs. 1, 2.
2003 *Belodella anomalis* COOPER – FARRELL, p. 120; Pl. 1, Figs. 6, 7.
2004 *Belodella anomalis* COOPER – FARRELL, p. 950; Pl. 1, Figs. 7, 8, 11, 14; Text-Fig. 4.

Description: The basal cavity is narrow but deep. The cross-section of the basal margin has a compressed triangular shape. A rather prominent denticulation rises along the anterior margin separating it into two ridges by a central longitudinal groove. Antero-lateral denticles towards the cusp remain prominent and bent proximally more to the posterior, but decrease in size when they reach the cusp. Those of the posterior margin are aligned and strongly sigmoidally curved with the cusp centred among the distal horizontal fan structure (in posterior view). The element is triangular in lateral view with a smooth surface.

Sc element (Pl. 4, Fig. 2)

1974 *Belodella anomalis* COOPER, p. 1121; Pl. 1, Figs. 2–3; Text-Fig. 1b.
2004 *Belodella anomalis* COOPER – FARRELL, p. 950; Pl. 1, Figs. 7–8, 11, 14; Text-Fig. 4.

Description: The lower margin is lenticular in outline with a basal cavity reaching almost to the anterior and posterior extremities. The anterior and posterior margins are denticulate. In lower view, marginal denticles are straight. Those of the anterior margin are inclined towards the cusp with the distalmost of them largest and aligned with the proximal part of the cusp forming the inner side of the fan. In posterior view, denticles of the posterior process are sigmoidally curved, joining the cusp on its outer side. Usually the cusp is rather prominent, but is fragmented in the figured element. The lateral outline of the element is almost triangular with a gently curved anterior margin. The observed specimen lacks surface texture.

Sd element (Pl. 4, Figs. 1, 3, 4)

1974 *Belodella anomalis* COOPER, p. 1121; Pl. 1, Figs. 1, 4–6; Text-Fig. 1e.
1999 *Belodella anomalis* COOPER – COCKLE, p. 118; Pl. 4, Figs. 5, 6.
2003 *Belodella anomalis* COOPER – ANDERSON, p. 472; Pl. 3, Figs. 13–17, 19–21, 24, 25.
2004 *Belodella anomalis* COOPER – FARRELL, p. 951; Pl. 1, Figs. 5, 6, 12, 15, 16; Text-Fig. 4.

Description: The element is triangular in lateral view. The basal margin more oval than lenticular, with an arcuate anterior (curving to the inner side), but a straight posterior denticulate margin (in lower view). The basal cavity is triangular, extending only half the height of the element in lateral view. Denticles along the posterior margin are aligned and sigmoidal, but less strongly curved in posterior view. Uppermost denticles near the cusp are reduced in length and do not develop a fan-like structure. The cusp is rather prominent and located terminal to adjacent posterior denticles (in posterior view). The lateral surface on either side is smooth.

Belodella resima (PHILIP, 1965)

Pl. 4, Figs. 9–12, 14–16, 18, 19, 21?, 22–24, 25?, 27, 28, 29?

General Remarks: Following recent publications (ANDERSON, 2003; FARRELL, 2004) the historical discrimination of the species *Belodella devonica, Belodella resima* and *Belodella triangularis*, on the basis of the outline of the basal margin (TELFORD, 1975), is avoided here. This results in a reconstructed multimembrate apparatus of *Belodella anomalis* including all three cross-section types. The outline of the cross-section becomes a significant feature for ascertaining the correct position of elements within the apparatus. Elements of *Belodella devonica* can be distinguished from *Belodella resima* in possessing prominent parallel costae running along the anterior margin on the inner lateral face. Depending on the specification of other features, the former *Belodella triangularis* is synonymized with *B. devonica, B. resima* being in the Sc position. The emended diagnosis proposed for belodellid apparatuses (especially for *Belodella devonica*) presented by ANDERSON (2003) are accepted here.

Material: 4520 specimens.

Sa element (Pl. 4, Figs. 14, 15, 27)

1975 *Belodella resima* (PHILIP) – TELFORD, p. 11; Pl. 1, Figs. 13–16; Pl. 2, Figs. 3, 4.
1987a *Belodella resima* (PHILIP) – MAWSON, Pl. 5, Figs. 11, 12.
1987b *Belodella resima* (PHILIP) – MAWSON, Pl. 41, Figs. 6–8.
1989 *Belodella resima* (PHILIP) – SORENTINO, p. 95; Pl. 8, Figs. 3, 5, 7.
1989 *Belodella resima* (PHILIP) – WILSON, Pl. 1, Figs. 1–3.
1994 *Belodella resima* (PHILIP) – MAWSON & TALENT, Fig. 15. H.
1995 *Belodella resima* (PHILIP) – MAWSON, TALENT & FUREY-GREIG, p. 424; Pl. 4, Figs. 2–5, 9.
1995 *Belodella resima* (PHILIP) – SLOAN, TALENT, MAWSON, SIMPSON, BROCK, ENGELBRETSEN, JELL, AUNG, PFAFFENRITTER, TROTTER & WITHNALL, Pl. 11, Figs. 3, 4.
2003 *Belodella resima* (PHILIP) – ANDERSON, p. 470; Pl. 1, Figs. 1–15.

2003 *Belodella resima* (PHILIP) – FARRELL, p. 121; Pl. 1, Figs. 19–21.
2003 *Belodella resima* (PHILIP) – MAWSON, TALENT, MOLLOY & SIMPSON, Pl. 5, Figs. 1–4, 10.
2004 *Belodella resima* (PHILIP) – FARRELL, p. 954; Pl. 2, Fig. 11.

Description: Sa elements are symmetrical. The outline of the lower margin is narrowly triangular with the anterior lower margin shorter in length compared to the lateral lower margin. Lateral faces are compressed, flat or expanded without any ornament. Either edge running along the anterior side forms a flange-like costa. Denticles along the posterior margin are fused at the base and relatively short; usually they have free ending tips, fragmented in most of the specimens. The cusp, free of denticles, is recurved distally and untwisted. The basal cavity is triangular in lateral view extending very deep to the distal part of the base.

Sb element (Pl. 4, Figs. 11, 18, 19, 21?)

1966 *Belodella* sp. cf. *B. devonica* (STAUFFER) – PHILIP, p. 444; Pl. 1, Figs. 22–24.
1971 *Belodella resima* (PHILIP) – REXROAD & CRAIG, p. 687; Pl. 79, Figs. 1, 2?, 3.
1975 *Belodella resima* (PHILIP) – TELFORD, p. 11; Pl. 1, Fig. 12.
1975 *Belodella triangularis* (STAUFFER) – TELFORD, p. 11; Pl. 2, Figs. 1, 2.
1987a *Belodella devonica* (STAUFFER) – MAWSON, Pl. 5, Figs. 6, 8.
1987a *Belodella resima* (PHILIP) – MAWSON, Pl. 5, Figs. 9, 10.
1987b *Belodella resima* (PHILIP) – MAWSON, Pl. 41, Fig. 5.
1989 *Belodella resima* (PHILIP) – MAWSON & TALENT, Pl. 8, Figs. 3, 4.
1989 *Belodella triangularis* (STAUFFER) – MAWSON & TALENT, Pl. 8, Fig. 5.
1989 *Belodella resima* (PHILIP) – SORENTINO, p. 95; Pl. 8, Figs. 1, 2.
1994 *Belodella resima* (PHILIP) – MAWSON & TALENT, Fig. 15. G.
1995 *Belodella resima* (PHILIP) – MAWSON, TALENT & FUREY-GREIG, p. 242; Pl. 4, Figs. 6–8.
1995 *Belodella resima* (PHILIP) – SLOAN, TALENT, MAWSON, SIMPSON, BROCK, ENGELBRETSEN, JELL, AUNG, PFAFFENRITTER, TROTTER & WITHNALL, Pl. 11, Figs. 5–10.
2003 *Belodella resima* (PHILIP) – ANDERSON, p. 470; Pl. 1, Figs. 16–20.
2003 *Belodella resima* (PHILIP) – FARRELL, p. 121; Pl. 1, Figs. 15, 16.
2004 *Belodella resima* (PHILIP) – FARRELL, p. 954; Pl. 2, Figs. 8, 12.

Description: Cones obtained are asymmetrical, exhibiting features nearly identical with those of elements in the Sa position. They differ only in possessing a twisted cusp.

Sc element (Pl. 4, Figs. 9, 22–24, 25?)

1968 *Belodus triangularis* STAUFFER – SCHULZE, p. 185; Pl. 16, Fig. 14?
1975 *Belodella triangularis* (STAUFFER) – TELFORD, p. 11; Pl. 1, Figs. 2-4.
1987a *Belodella triangularis* (STAUFFER) – MAWSON, Pl. 5, Fig. 13.
1987b *Belodella triangularis* (STAUFFER) – MAWSON, Pl. 41, Fig. 9.
1989 *Belodella triangularis* (STAUFFER) – SORENTINO, p. 95; Pl. 8, Fig. 4.
1989 *Belodella triangularis* (STAUFFER) – WILSON, Pl. 1, Figs. 8, 9.
1994 *Belodella triangularis* (STAUFFER) – MAWSON & TALENT, Fig. 15. N–P.
1995 *Belodella resima* (PHILIP) – SLOAN, TALENT, MAWSON, SIMPSON, BROCK, ENGELBRETSEN, JELL, AUNG, PFAFFENRITTER, TROTTER & WITHNALL, Pl. 11, Figs. 11–14.
1998 *Belodella resima* PHILIP – SLAVÍK, p. 160; Pl. 2, Fig. 5.
2003 *Belodella resima* (PHILIP) – ANDERSON, p. 470; Pl. 2, Figs. 1-6.
2003 *Belodella resima* (PHILIP) – FARRELL, p. 121; Pl. 1, Fig. 14.
2003 *Belodella resima* (PHILIP) – MAWSON, TALENT, MOLLOY & SIMPSON, Pl. 5, Figs. 5, 11.
2004 *Belodella resima* (PHILIP) – FARRELL, p. 954; Pl. 2, Fig. 9.

Description: Generally the element is asymmetrical with the surface of the outer side convex. Lateral walls are flat, compressed or expanded, remaining unornamented. The basal margin of the cone is triangular in lower view. Denticles along the posterior margin are small and fused at the base. The posterior margin and the cusp forms an angle of more than 90 degrees resulting in strong twisting of the tip of the cusp towards the inner side; it appears more recurved in some of the figured specimens.

Sd element (Pl. 4, Figs. 10, 12, 29?)

1975 *Belodella devonica* (STAUFFER) – TELFORD, p. 10; Pl. 1, Figs. 5–9.
1987a *Belodella devonica* (STAUFFER) – MAWSON, Pl. 5, Figs. 4, 5, 7.
1987b *Belodella devonica* (STAUFFER) – MAWSON, Pl. 41, Figs. 1–4.
1989 *Belodella devonica* (STAUFFER) – MAWSON & TALENT, Pl. 8, Figs. 1, 2.
1989 *Belodella devonica* (STAUFFER) – WILSON, Pl. 1, Figs. 4–7.
1995 *Belodella resima* (PHILIP) – FUREY-GREIG, Pl. 2, Figs. 1, 2.
2003 *Belodella resima* (PHILIP) – ANDERSON, p. 470; Pl. 2, Figs. 7–14.
2003 *Belodella resima* (PHILIP) – FARRELL, p. 121; Pl. 1, Fig. 17.
2004 *Belodella resima* (PHILIP) – FARRELL, p. 954; Pl. 2, Figs. 6, 7.

Description: The cross-section of basal margin is lenticular. Lateral walls are expanded and show no surface texture. Posterior denticulation can extend along the entire posterior margin, but in some specimens denticles cover only up to 80 percent and are lacking beneath the cusp. The cusp is untwisted but strongly recurved into an angle of less than 90 degree to the posterior margin.

T element (Pl. 4, Fig. 28)

1975 *Belodella resima* (PHILIP) – TELFORD, p. 11; Pl. 1, Fig. 11.
1987a *Belodella resima* (PHILIP) – MAWSON, Pl. 5, Fig. 12.
1987b *Belodella resima* (PHILIP) – MAWSON, Pl. 41, Fig. 6.
1989 *Belodella resima* (PHILIP) – SORENTINO, p. 95; Pl. 8, Fig. 6.
2003 *Belodella resima* (PHILIP) – ANDERSON, p. 470; Pl. 2, Figs. 18–23.
2004 *Belodella resima* (PHILIP) – FARRELL, p. 954; Pl. 2, Fig. 10.

Description: Elements possess a less prominent costa on the outer side running along the anterior margin. Lateral faces of specimens are unornamented. The area of the upper half from one-third of the base until the tip of the cusp is strongly twisted. The cusp is recurved. Denticles along the posterior margin are small, fused at the base and aligned to the cusp proximally.

M element (Pl. 4, Fig. 16)

1965 *Paltodus valgus* sp. nov. PHILIP, p. 98; Pl. 8, Figs. 7, 8.
1975 *Belodella triangularis* (STAUFFER) – TELFORD, p. 11; Pl. 1, Fig. 1.
1987b *Panderodus valgus* (PHILIP) – MAWSON, Pl. 41, Fig. 10.
1989 *Panderodus valgus* (PHILIP) – MAWSON & TALENT, Pl. 8, Figs. 21, 22.
?1989 *Belodella triangularis* (STAUFFER) – SORENTINO, p. 95; Pl. 8, Figs. 9, 10.
1989 *Panderodus valgus* (PHILIP) – SORENTINO, p. 95; Pl. 8, Figs. 12, 13.
1994 *Panderodus valgus* (PHILIP) – MAWSON & TALENT, Fig. 15. C, E?
1995 *Belodella resima* (PHILIP) – MAWSON, TALENT & FUREY-GREIG, p. 424; Pl. 4, Fig. 1.
1995 *Belodella resima* (PHILIP) – SLOAN, TALENT, MAWSON, SIMPSON, BROCK, ENGELBRETSEN, JELL, AUNG, PFAFFENRITTER, TROTTER & WITHNALL, Pl. 11, Fig. 2.
2003 *Belodella resima* (PHILIP) – ANDERSON, p. 470; Pl. 2, Figs. 15–17.
2003 *Belodella resima* (PHILIP) – FARRELL, p. 121; Pl. 1, Fig. 18.
2003 *Belodella resima* (PHILIP) – MAWSON, TALENT, MOLLOY & SIMPSON, Pl. 5, Fig. 6.
2004 *Belodella resima* (PHILIP) – FARRELL, p. 954; Pl. 2, Fig. 13.

Description: Specimens have a smooth lateral surface. The cross-section of the lower margin is symmetrical. The cusp is gently curved but untwisted. No denticles are developed along the posterior margin. One of the elements figured differs a little in possessing a more concave posterior margin.

Belodella striata KOZUR, 1984

Pl. 4, Figs. 13, 17, 20?, 26; Pl. 5, Fig. 3

General Remarks: Distinctive for this taxon is the development of fine longitudinal striation, lacking in all other species of *Belodella*. For *Belodella striata* from localities in Australia, a range restricted to the Pragian (*sulcatus-pireneae* Zone) is concluded by ANDERSON (2003). BARRICK & KLAPPER (1992) obtained specimens in a section of Lochkovian age in Oklahoma. ANDERSON (2003) remarked, that their material cannot be assigned to *B. striata* with certainty due to pure preservation. Extending the range down to the Lochkovian remains questionable, though some elements from the Rauchkofel Formation of the Seewarte section were obtained from beds referred to the *pesavis* Zone.

Material: 8 specimens.

Sa element (Pl. 4, Figs. 13, 20?, 26)

1984 *Belodella striata* n. sp. KOZUR, p. 152; Pl. 9, Fig. 1.
1995 *Belodella* sp. cf. *B. striata* KOZUR – BARRICK & NOBLE, p. 1120; Fig. 6.1.

Description: Elements are symmetrical with triangular outline of the lower margin. Anterior and lateral faces are flat. A fine striated ornament is visible only at high magnification, extending nearly half the length on lateral faces. In some specimens surface texture is strongly etched and ornament therefore only partly preserved. A weakly developed flange-like costa runs along the edge of the anterior margin. The tiny denticles of the posterior margin are fused at the base, extending to the base of the cusp. The cusp is gently curved and untwisted. The basal cavity is very deep and triangular in lateral view.

Sb element (Pl. 4, Fig. 17)

1995 *Belodella* sp. cf. *B. striata* KOZUR – BARRICK & NOBLE, p. 1120; Figs. 6.2–6.4.
2003 *Belodella striata* KOZUR – ANDERSON, p. 473; Pl. 3, Figs. 7–12.

Description: The Sb element has an asymmetrical deformed lenticular(?) cross-section with the lower basal margin of lateral walls curved and somewhat compressed centrally. One edge bordering the anterior margin is slightly convex. The second edge shows a weak flange-like costa. The posterior margin is covered with very small denticles extending to the base of the curved cusp. Striation is visible in the posterior to mid region on lateral faces. The basal cavity is triangular in lateral view, reaching to the base of the cusp. The element is slightly twisted.

Remarks: The slight twisting of the element contrasts with the description in ANDERSON (2003), where the cusp remains only gently curved. The cross-section cannot be defined clearly, whether lenticular or triangular, as some specimens have fractured or deformed basal walls.

M element (Pl. 5, Fig. 3)

1984 *Belodella* sp. cf. *B. striata* KOZUR, p. 152; Pl. 9, Fig. 2; Pl. 10, Fig. 1.
1995 *Belodella* sp. cf. *B. striata* KOZUR – BARRICK & NOBLE, p. 1120; Fig. 6.5.
2003 *Belodella striata* KOZUR – ANDERSON, p. 473; Pl. 3, Figs. 5, 6.

Description: The M element lacks denticulation along the posterior margin. A nearly symmetrical cross-section (outline lenticular) with compressed mid area (described as: curving inward and outward of lateral faces). The anterior margin forms a flange-like costa. Fine, parallel striae cover the entire lateral face on either side. The cusp (tip broken) is gently curved along the entire length of the element.

Genus: *Coelocerodontus* ETHINGTON, 1959

Type species: *Coelocerodontus trigonius* ETHINGTON, 1959.

Coelocerodontus cf. *C. reduncus* TELFORD, 1975

Material: 1 specimen.

Trigoniform element

cf. 1975 *Coelocerodontus reduncus* sp. nov. TELFORD, p. 16; Pl. 3, Figs. 1–3.
cf. 1989 *Coelocerodontus reduncus* TELFORD – MAWSON & TALENT, Pl. 8, Fig. 20.
cf. 1989 *Coelocerodontus reduncus* TELFORD – SORENTINO, p. 95; Pl. 8, Figs. 14?, 15.
cf. 1990 *Coelocerodontus trigonius* ETHINGTON – UYENO, p. 75; Pl. 1, Figs. 11, 12, 33, 34.
cf. 1995 *Coelocerodontus reduncus* TELFORD – MAWSON, TALENT & FUREY-GREIG, p. 427.
cf. 1995 *Coelocerodontus reduncus* TELFORD – SIMPSON & TALENT, p. 125.
cf. 1995 *Coelocerodontus* sp. cf. *C. reduncus* TELFORD – SLOAN, TALENT, MAWSON, SIMPSON, BROCK, ENGELBRETSEN, JELL, AUNG, PFAFFENRITTER, TROTTER & WITHNALL, Pl. 11, Fig. 15; Pl. 13, Figs. 20?, 21, 22.

Description: The cone has a broad triangular cross-section of the basal margin, with keels on antero-lateral and posterior margins. Keels are strongly developed. Anterior and lateral faces are almost of equal width. The apical area of the cusp is curved, including an angle of about 90 degrees. The basal cavity is triangular in lateral view and very deep, extending almost to the part of recurvature of the cusp.

Remarks: ORCHARD (1980), SIMPSON & TALENT (1995) and other authors proposed that the apparatus of *Coelocerodontus* is a bimembrate one, consisting of tri- and tetragoniform elements. Tetragoniform elements are described mainly from the Ordovician. Apparatus reconstructions of Upper Cambrian and Tremadocian clusters of *Coelocerodontus* (MÜLLER & HINZ, 1991; ANDRES, 1988 respectively) include at least four different types of elements. Based on these early Palaeozoic clusters, SANSOM et al. (1994) proposed a multimembrate reconstruction for *Coelocerodontus* consisting of arcuatiform, asymmetric graciliform, falciform, tortiform and possibly aequaliform elements (Text-Fig. 8, therein).

Genus: *Dvorakia* KLAPPER & BARRICK, 1983

Type species: *Dvorakia chattertoni* KLAPPER & BARRICK, 1983.

Dvorakia aff. *D. chattertoni* KLAPPER & BARRICK, 1983

Pl. 5, Figs. 16, 17

Material: 10 specimens.

Sb element (Pl. 5, Fig. 16)

aff. 1983 *Dvorakia chattertoni* n. sp. KLAPPER & BARRICK, p. 1227; Figs. 8M, 8O, 8P, 8Q, 8S.

Description: The outline of the basal margin is almost triangular with a broad flat anterior margin and slightly curved lateral walls. The inner antero-lateral edge has a flange-like costa. The posterior margin is keeled. Lateral faces show two weak longitudinal costae in the posterior half. Costae do not extend along the entire length of the element. The cusp is strongly recurved, including an angle to the posterior margin of about 104 degrees.

Sc element (Pl. 5, Fig. 17)

aff. 1983 *Dvorakia chattertoni* n. sp. KLAPPER & BARRICK, p. 1227; Figs. 8L, 8R.

Description: The cross-section of the lower margin is convex on the outer side, but rather straight on the inner. A flange-like costa, a little wider in the lower half, is visible on the inner antero-lateral margin. The posterior margin resembles a broad keel. The outer surface remains smooth, whereas the inner one exhibits three weakly developed longitudinal costae in the posterior third. Costae do not extend along the entire length of the element. The cusp is strongly recurved, including an angle to the posterior margin of about 107 degrees.

Dvorakia klapperi (Chatterton, 1974)

Pl. 6, Fig. 13; Pl. 7, Fig. 5

Material: 13 specimens.

Sb? element (Pl. 6, Fig. 13)

1983 *Dvorakia klapperi* (Chatterton) – Klapper & Barrick, p. 1229; Figs. 8B, 8D, 8E [cum syn.].

Description: The asymmetrical cross-section shows a straight, flat anterior lower margin and two strongly rounded lateral lower margins twice the length. The inner antero-lateral and the posterior margin are keeled. Lateral faces are covered by approximately 10 longitudinal costae parallel to the anterior margin. The anterior margin is gently curved with the degree of curvature increasing towards the apex. The cusp is gently twisted with the tip pointing towards the inner side.

Remarks: The figured specimen differs from those of Klapper & Barrick (1983) by displaying a higher number of costae on lateral faces.

Sd element (Pl. 7, Fig. 5)

1983 *Dvorakia klapperi* (Chatterton) – Klapper & Barrick, p. 1229; Fig. 8F [cum syn.].

1989 *Dvorakia klapperi* (Chatterton) – Mawson & Talent, Pl. 8, Fig. 9.

Description: The cross-section of the element is almost oval. A weak antero-lateral keel is slightly rotating from base to apex. Distinct costae on lateral faces are almost equally spaced from each other, except for spacing between the costae adjacent to the antero-lateral keel on the inner side, where the distance is little wider. No posterior keel is recognizable. The anterior margin is gently curved with the cusp being vertical.

Dvorakia sp. A

Pl. 4, Figs. 7, 8

Material: 6 specimens.

Remarks: Obtained specimens, though denticulate, seem to belong to the genus *Belodella* at first glance. Closer investigations have shown, that elements differ markedly in some features, suggesting a position within the genus *Dvorakia* rather than *Belodella*. Denticles along the posterior margin are laterally flattened to conical in shape. They differ from those of *Belodella*, in being discrete, much larger and very wide spaced. The cross-section of the elements can be triangular (Plate 4, Fig. 7) or lenticular (Plate 4, Fig. 8). The anterior margin has a keel developed on one side, tapered towards the tip. One element (Plate 4, Fig. 7) has a wrinkle zone developed close to the lower margin. Specimens are observed in Lochkovian and Pragian strata of the Seewarte section (*delta*- to *celtibericus* Zone).

Dvorakia sp.

Pl. 5, Figs. 1, 2, 4, 6, 10, 14, 18

Material: 222 specimens.

Remarks: Several elements of *Dvorakia* sp. are obtained. Most of them possess a slightly asymmetrical but oval cross-section with lateral faces compressed, or a triangular cross-section with either a straight or a rounded anterior lower margin. An anterior keel can be developed. The curvature of the cusp ranges from gently curved to recurved. Some elements do have few fine striae close to the posterior margin, but usually lateral faces are smooth. Some specimens are similar to that one figured in Farrell, 2004 (Plate 2, Fig. 14). For further comments on the genus *Dvorakia* compare Simpson & Talent, 1995 (page 125).

Genus: *Walliserodus* Serpagli, 1967

Type species: *Acodus curvatus* Branson & Branson, 1947.

Walliserodus multistriatus Farrell, 2004

Pl. 6, Fig. 14

Material: 8 specimens.

Sa? element (Pl. 6, Fig. 14)

2004 *Walliserodus multistriatus* Farrell, p. 955; Pl. 3, Figs. 1–3, 5, 6, 11.

Description: The cusp is erect, possessing a gently curved anterior margin (keeled?). Well developed striae on the posterior area of the lateral faces run parallel to the anterior margin. The striated texture covers nearly two-thirds of the surface including an angle of about 35 degrees to the posterior margin. Extending nearly to the faintly developed wrinkle zone, striae become almost vertical. The cross-section of the element is broadly oval, with lateral faces being pinched in the posterior third. The distal part of the cone and the cusp are compressed.

Remarks: A diagnostic feature of the species *Walliserodus multistriatus* is the outline of the basal margin and the characteristic striation extending at a low angle from the posterior margin towards the base on each lateral face.

Order Protopanderodontida Sweet, 1988
Family Protopanderodontidae Lindström, 1970
Genus *Pseudooneotodus* Drygant, 1974

Type species: *Oneotodus* ? *beckmanni* Bischoff & Sannemann, 1958.

Pseudooneotodus beckmanni (Bischoff & Sannemann, 1958)

Pl. 6, Figs. 16, 17; Pl. 7, Figs. 1–4

Material: 360 specimens.

1958 *Oneotodus* ? *beckmanni* n. sp. Bischoff & Sannemann, p. 98; Pl. 15, Figs. 22–25.

1966 *'Oneotodus' beckmanni* Bischoff & Sannemann – Clark & Ethington, p. 680; Pl. 83, Figs. 1, 2.

1969b *'Oneotodus'* n. sp. Pölsler, p. 409; Pl. 1, Fig. 15.

1977 *Pseudooneotodus beckmanni* (Bischoff & Sannemann) – Cooper, p. 1068; Pl. 2, Figs. 14, 17 [cum syn.].

1985a *Pseudooneotodus beckmanni* (Bischoff & Sannemann) – Mastandrea, Pl. 1, Fig. 10.

1990 *Pseudooneotodus beckmanni* (Bischoff & Sannemann) – Uyeno, p. 99; Pl. 1, Figs. 36, 37.

1994 *Pseudooneotodus beckmanni* (Bischoff & Sannemann) – Mawson & Talent, Fig. 15 J–L.

1998b *Pseudooneotodus beckmanni* Bischoff & Sannemann – Corradini, Ferretti & Serpagli, Pl. 3.3.1, Fig. 16.

1998 *Pseudooneotodus beckmanni* (Bischoff & Sannemann) – Kozur, Pl. 1, Fig. 3.

1998 *Pseudooneotodus beckmanni* Bischoff & Sannemann – Serpagli, Corradini & Ferretti, Pl. 1.2.1, Fig. 14.

1999 *Pseudooneotodus beckmanni* (BISCHOFF & SANNEMANN) – COCKLE, p. 119; Pl. 1, Figs. 1–2.
1999 *Pseudooneotodus beckmanni* (BISCHOFF & SANNEMANN) – TALENT & MAWSON, Pl. 13, Figs. 1–7.
2003 *Pseudooneotodus beckmanni* (BISCHOFF & SANNEMANN) – MAWSON, TALENT, MOLLOY & SIMPSON, Pl. 5, Figs. 13, 14.
2004 *Pseudooneotodus beckmanni* (BISCHOFF & SANNEMANN) – FARREL, p. 956; Pl. 2, Figs. 15–17.
2006 *Pseudooneotodus beckmanni* (BISCHOFF & SANNEMANN) – MATHIESON, p. 24; Pl. 1, Figs. Q–S.

Description: The outline of the lower basal margin is circular to subcircular in small (juvenile?) specimens, whereas adult cones show more angular (subtriangular) rather than circular basal margins. The anterior margin is narrowed and steeply inclined compared to the broad and more gently inclined posterior one. A conspicuous rim on the anterior margin is developed in the upper half to upper third of the entire length. The tip of the cusp is centred in upper view, but slightly directed posteriorly. The apex normally is rounded, but some specimens have an acute and slightly reclined one. The basal cavity in lower view reaches almost to the tip. A few cones have a prominent furrow within the antero-lateral face of the narrow anterior margin (compare Plate 7, Fig. 1). The surface of the cone in general is smooth to very fine, unevenly striated.

Remarks: Some specimens are close in shape to those published by FARRELL (2004). They only differ in the absence or low developed necking around the cone below the bulging rim. Other elements show a similar strong constriction, which is restricted to the area of the anterior margin extending maximally to the anterior-lateral face herein.

Family: Drepanoistodontinae FÅHRAEUS & NOWLAN, 1978
Genus: *Decoriconus* COOPER, 1975

Type species: *Paltodus costulatus* REXROAD, 1967.

Decoriconus fragilis (BRANSON & MEHL, 1933)

Pl. 7, Figs. 12–21

General Remarks: *Decoriconus fragilis* tends to appear mainly in strata of Silurian age. FARRELL (2003) reported specimens from the Gap area (New South Wales, Australia) occurring within the *eosteinhornensis* to *woschmidti* Zones. According to BARRICK & KLAPPER (1992), the species extends into the *eurekaensis* Zone. Specimens from the Seewarte section occur up to middle Pragian.

Material: 1160 specimens.

Sa element (Pl. 7, Figs. 14, 17, 18)

1971 *Paltodus fragilis* BRANSON & MEHL – REXROAD & CRAIG, p. 694; Pl. 79, Fig. 17.
1976 *Decoriconus fragilis* (BRANSON & MEHL) – COOPER, p. 212; Pl. 2, Fig. 15 [cum syn.].
1977 *Decoriconus fragilis* (BRANSON & MEHL) – BARRICK, p. 53; Pl. 2, Fig. 23.
1990 *Decoriconus fragilis* (BRANSON & MEHL) – UYENO, p. 98; Pl. 11, Figs. 14, 16.
1998 undetermined coniform conodonts KOZUR, Pl. 1, Fig. 23?
2003 *Decoriconus fragilis* (BRANSON & MEHL) – FARRELL, p. 151; Pl. 12, Figs. 14, 17.
2004 *Decoriconus fragilis* (BRANSON & MEHL) – FARRELL, p. 958; Pl. 8, Figs. 16–17.

Description: The outline of the basal cavity is nearly lens-shaped, whereas the cusp has a keeled cross-section. Cones possess an erect, almost untwisted cusp. A shallow curved furrow is developed on either side of the anterior lateral face. Narrow longitudinal grooves on both sides of the posterior keel extend from the upper margin of the base to the tip of the cusp, but the deep incision does not reach the basal margin. It changes into a shallow furrow running downward towards the posterior lower margin. In lateral view the convex lower margin meets the anterior margin at an angle of about 120 degrees. The vertex of the cone's posterior curvature is located in the lowermost quarter of the cone displaying an angle of 20–25 degrees (inclination posteriorward). The cross-section at the height of the vertex of the posterior margin represents three measuring lengths (first length: anterior margin to anterior furrow; second length: anterior furrow to posterior groove; third length: posterior groove to posterior margin of the keel). A more or less distinct ratio is observed (e.g., for Sa elements 1:1:0.75). The surface of the cone shows fine parallel striae, almost restricted to the cusp and the narrow area of the anterior margin where few striae reach the basal margin. Usually the posterior keel and the base are unornamented.

Sb element (Pl. 7, Figs. 12, 13, 20, 21)

1971 *Drepanodus aduncus* NICOLL & REXROAD – REXROAD & CRAIG, p. 690; Pl. 79, Figs. 11–14.
1976 *Decoriconus fragilis* (BRANSON & MEHL) – COOPER, p. 212; Pl. 2, Figs. 5, 8 [cum syn.].
1977 *Decoriconus fragilis* (BRANSON & MEHL) – BARRICK, p. 53; Pl. 2, Fig. 21.
1991 *Decoriconus fragilis* (BRANSON & MEHL) – MCCRACKEN, p. 79; Pl. 4, Fig. 33?
1995 ? *Decoriconus fragilis* (BRANSON & MEHL) – SIMPSON & TALENT, p. 175; Pl. 12, Figs. 10?, 11.
2003 *Decoriconus fragilis* (BRANSON & MEHL) – FARRELL, p. 151; Pl. 12, Figs. 11, 12.

Description: The basal cavity has a keeled outline with a small posterior and a wider anterior keel tapering towards the apex. A weak twisting of the cusp is visible.The anterior margin is slightly arcuate including an angle of 45–50 degrees within a rather straight basal margin. In lateral view the vertex of the posterior keel's curvature is located in the lower third of the cone possessing an angle of 45–55 degrees. Different from the Sa element the lower part of the posterior keel looks beak-like. The cross-section at the height of the vertex of the posterior margin shows a ratio of 1 : 0.8 : 0.2. The incision of the longitudinal posterior grooves, as well as the pattern of ornament of the cone's surface resemble those in the Sa elements.

Sb ? element (Pl. 7, Fig. 19)

1971 *Paltodus fragilis* BRANSON & MEHL – REXROAD & CRAIG, p. 694; Pl. 79, Figs. 8, 9.
1990 *Decoriconus fragilis* (BRANSON & MEHL) – UYENO, p. 98; Pl. 11, Fig. 15.
1991 *Decoriconus fragilis* (BRANSON & MEHL) – MCCRACKEN, p. 79; Pl. 4, Fig. 39.

Description: Obtained elements have several features like the Sb element (e.g., outline of basal cavity, position of vertex of the posterior curvature, beak-like lower part of the posterior keel). They differ in possessing a more prominent posterior keel, with a ratio of the cross-section at the height of the vertex of the posterior margin (1 : 0.9 : 0.8) having affinity to that of an Sa element. The angle of the straight basal to anterior margin spans 65 degrees and to the posterior margin shows an inclination of 25–30 degrees.

Sa-Sb element (Pl. 7, Figs. 15, 16)

1971 *Paltodus fragilis* BRANSON & MEHL – REXROAD & CRAIG, p. 694; Pl. 79, Figs. 15?, 16.
1976 *Decoriconus fragilis* (BRANSON & MEHL) – COOPER, p. 212; Pl. 2, Figs. 14, 16, 17 [cum syn.].
1977 *Decoriconus fragilis* (BRANSON & MEHL) – BARRICK, p. 53; Pl. 2, Fig. 22.
1998 undetermined coniform conodonts KOZUR, Pl. 1, Fig. 22?

Description: The outline of the basal cavity is keeled to lens- shaped, reflected by only narrow developed keels. Distinct is the strongly twisted cusp possessing an angle of 40–45 degrees with the vertex of the curvature of the inner lateral face located in the lower third to middle height of the cone in anterior view. In lateral view (compare Plate 7, Fig. 15a) the anterior margin seems to be rectangular to the straight basal margin and only slightly bent. The cone's posterior curvature runs consecutively like in Sa elements, possessing an angle of 25–30 degrees (ratio of the cross-section close to the vertex of the posterior margin: 0.5 : 1 : 0.5). Minor difference from Sa and Sb elements reflects the microornament. Striation of the anterior margin in Sa-Sb elements is poorly developed to absent. An additional difference is a more prominent anterior furrow.

Order: Panderodontida SWEET, 1988
Family: Panderodontidae LINDSTRÖM, 1970
Genus: *Neopanderodus* ZIEGLER & LINDSTRÖM, 1971

Type species: *Neopanderodus perlineatus* ZIEGLER & LINDSTRÖM, 1971.

Neopanderodus aequabilis TELFORD, 1975

Pl. 6, Figs. 6, 7

Material: 42 specimens.

Sa element (Pl. 6, Figs. 6, 7)

1989 *Neopanderodus aequabilis* TELFORD – MAWSON & TALENT, Pl. 8, Figs. 14, 15.
1989 *Neopanderodus* sp. SORENTINO, p. 95; Pl. 8, Fig. 16.
1994 *Neopanderodus aequabilis* TELFORD – MAWSON & TALENT, Fig. 15. A.
1995 *Neopanderodus* spp. CAREY & BOLGER, p. 84; Figs. 4O, 4P.
1995 *Neopanderodus aequabilis* TELFORD – MAWSON, TALENT & FUREY-GREIG, p. 428; Pl. 4, Figs. 15–17.
2003 *Neopanderodus aequabilis* TELFORD – ANDERSON, p. 468; Pl. 4, Figs. 1–14.
2003 *Neopanderodus aequabilis* TELFORD – MAWSON & TALENT, p. 344; Pl. 1, Fig. 14.

Description: Obtained elements have a symmetrical cross-section in outline. The lower part of the base exhibits a small wrinkle zone and shows a nearly straight lower margin in lateral view. Specimens are untwisted, with a gently curved cusp. Lateral faces bear a depression in the posterior third. One side shows a groove that extends along the entire length distally. Lateral faces are ornamented with typical longitudinal striae. Striation of one of the illustrated elements (Plate 6, Fig. 7) runs parallel to the posterior margin covering the entire lateral face. The texture of the anterior two-thirds on the lateral face of the second element (Plate 6, Fig. 6) differs a little. It shows longitudinal striae at an acute angle to the groove.

Neopanderodus leptostriatus ANDERSON, 2003

Pl. 6, Fig. 1

Material: 30 specimens.

? Sa element (Pl. 6, Fig. 1)

1995 *Neopanderodus* spp. CAREY & BOLGER, p. 84; Figs. 4Q?, 4R?
2003 *Neopanderodus leptostriatus* n. sp. ANDERSON, p. 469; Pl. 7, Figs. 1–6, 13, 14.

Description: The basal margin of the illustrated element is fragmented and therefore the cross-section seems asymmetrical. The element is untwisted. The anterior margin is continuously curved from the base to the top. Lateral faces show a longitudinal depression almost centred near the base tapering distally towards the posterior end. Striae on the posterior half of either lateral face run parallel to the posterior margin, whereas those of the anterior part show an acute angle to the groove on the outer side, and a channel-like depression on the inner side. Longitudinal striae are distinctive, possessing narrow, but uniform intervals between each other.

Remarks: Elements of this species can be distinguished from *Neopanderodus aequabilis* by the finer, but still prominent longitudinal striation that covers only a part or the entire surface of the cone. ANDERSON (2003) pointed out that elements on average possess between 100–220 striae per mm in comparison to *Neopanderodus aequabilis* where up to 100 occur per mm.

Neopanderodus sp.

Pl. 6, Fig. 9

Material: 18 specimens.

? Sc element (Pl. 6, Fig. 9)

Description: The element is broken, lacking most of the lower part including the wrinkle zone (if present?). The anterior margin gradually curves distally, becoming more recurved in the upper part. The posterior margin is rather straight, joining the curvate base of the cusp at two-thirds of the height. Longitudinal striae are parallel to the groove, covering the entire lateral face. Striae are densely spaced in the posterior half of the lateral face, becoming gradually wider towards the anterior smooth margin.

Remarks: The illustrated element differs from other species in possessing irregular intervals between longitudinal striae that become gradually wider-spaced towards the anterior margin. It remains unclear whether the surface ornament represents a significant feature or is only the result of poor preservation.

Genus: *Panderodus* ETHINGTON, 1959

Type species: *Paltodus unicostatus* BRANSON & MEHL, 1933.

Panderodus recurvatus (RHODES, 1953)

Material: 2 specimens.

1971 *Panderodus recurvatus* (RHODES) – REXROAD & CRAIG, p. 696; Pl. 81, Figs. 23–25.
1975 *Panderodus recurvatus* (RHODES) – TELFORD, p. 37; Pl. 3, Figs. 4–7.
1977 *Panderodus recurvatus* (RHODES) – BARRICK, p. 54; Pl. 3, Figs. 3, 4, 7–12.
1987b *Panderodus recurvatus* (RHODES) – MAWSON, Pl. 41, Figs. 14, 15.
1989 *Panderodus recurvatus* (RHODES) – MAWSON & TALENT, Pl. 8, Figs. 11–13.
1989 *Panderodus recurvatus* (RHODES) – WILSON, Pl. 1, Figs. 10–12.
1994 *Panderodus recurvatus* (RHODES) – MAWSON & TALENT, Fig. 15. D.
1995 *Panderodus recurvatus* (RHODES) – FUREY-GREIG, Pl. 2, Figs. 14?, 15.
1995 *Panderodus recurvatus* (RHODES) – SIMPSON & TALENT, p. 117; Pl. 1, Figs. 21–27 [cum syn.].
1999 *Panderodus recurvatus* (RHODES) – COCKLE, p. 120; Pl. 5, Figs. 9–14.
2003 *Panderodus recurvatus* (RHODES) – FARRELL, p. 122; Pl. 1, Fig. 2.
2004 *Panderodus recurvatus* (RHODES) – FARRELL, p. 958; Pl. 3, Figs. 9, 12, 13.
2005 *Panderodus recurvatus* (RHODES) – TROTTER & TALENT, p. 42; Pl. 18, Fig. 22.
2006 *Panderodus recurvatus* (RHODES) – MATHIESON, p. 26; Pl. 1, Figs. I–M.

Remarks: Only two elements are obtained, possessing a strongly recurved cusp as distinctive for this species. The anterior margin is flattened at mid-height. Except for symmetrical Sa elements the cusp is twisted at various degrees according to position within the apparatus. The longitudinal groove is located in the posterior third along the depression of lateral faces. It extends from the base to the apex on one side in Sb, Sc and M elements. Only Sa elements show a furrow on each lateral side. The anterior and posterior margin can be keeled (Sc and M elements). Sa elements have a costa on each lateral face, which usually is located in the anterior half. Sb elements bear only one costa along the outer anterior margin. M elements lack any costa on the lateral faces. A pronounced wrinkle zone is developed close to the lower margin. The area of the posterior one-third to the posterior half can be covered by fine longitudinal striae.

Panderodus unicostatus (BRANSON & MEHL, 1933)

Pl. 5, Figs. 11, 12; Pl. 6, Figs. 2–5, 11?

Material: 1727 specimens.

1933 *Paltodus unicostatus* n. sp. BRANSON & MEHL, p. 42; Pl. 3, Fig. 3.
1966 *Panderodus unicostatus* (BRANSON & MEHL) – CLARK & ETHINGTON, p. 683; Pl. 82, Figs. 17, 19.
1971 *Panderodus gracilis* (BRANSON & MEHL) – REXROAD & CRAIG, p. 695; Pl. 81, Figs. 28, 29.
1971 *Panderodus simplex* (BRANSON & MEHL) – REXROAD & CRAIG, p. 697; Pl. 81, Figs. 35–40.
1971 *Panderodus unicostatus* (BRANSON & MEHL) – REXROAD & CRAIG, p. 697; Pl. 81, Figs. 30–34.
1971 *Panderodus* n. sp. REXROAD & CRAIG, p. 698; Pl. 81, Figs. 26, 27.
1975 *Panderodus simplex* (BRANSON & MEHL) – TELFORD, p. 38; Pl. 3, Fig. 12.
1975 *Panderodus unicostatus* (BRANSON & MEHL) – TELFORD, p. 38; Pl. 3, Fig. 11.
1976 *Panderodus unicostatus* (BRANSON & MEHL) – COOPER, p. 213; Pl. 1, Figs. 1–7, 22.
1977 *Panderodus unicostatus* (BRANSON & MEHL) – BARRICK, p. 56; Pl. 3, Figs. 1, 2, 5, 6.
1983 *Panderodus unicostatus* (BRANSON & MEHL) – MABILLARD & ALDRIDGE, Pl. 4, Figs. 9–14.
1987a *Panderodus unicostatus* (BRANSON & MEHL) – MAWSON, Pl. 5, Fig. 17.
1987b *Panderodus unicostatus* (BRANSON & MEHL) – MAWSON, Pl. 41, Figs. 12, 13.
1989 *Panderodus unicostatus* (BRANSON & MEHL) – MAWSON & TALENT, Pl. 8, Fig. 17.
1989 *Panderodus unicostatus* (BRANSON & MEHL) – SORENTINO, p. 95; Pl. 7, Figs. 12, 13, 15, 16, 20.
1989 *Panderodus unicostatus* (BRANSON & MEHL) – WILSON, Pl. 1, Figs. 17–22.
1990 *Panderodus unicostatus* (BRANSON & MEHL) – UYENO, p. 70; Pl. 1, Figs. 27, 28, 32; Pl. 4, Fig. 10.
1994 *Panderodus unicostatus* (BRANSON & MEHL) – MAWSON & TALENT, Fig. 15. B.
1995 *Panderodus unicostatus* (BRANSON & MEHL) – COLQUHOUN, Pl. 3, Fig. 3.
1995 *Panderodus unicostatus* (BRANSON & MEHL) – FUREY-GREIG, Pl. 2, Figs. 3–12.
1995 *Panderodus unicostatus* (BRANSON & MEHL) – SIMPSON & TALENT, p. 118; Pl. 2, Figs. 1–32 [cum syn.].
1995 *Panderodus unicostatus* (BRANSON & MEHL) – SLOAN, TALENT, MAWSON, SIMPSON, BROCK, ENGELBRETSEN, JELL, AUNG, PFAFFENRITTER, TROTTER & WITHNALL, Pl. 11, Fig. 17; Pl. 12, Fig. 4; Pl. 13, Fig. 8.
1998 *Panderodus unicostatus* (BRANSON & MEHL) – SLAVÍK, p. 163; Pl. 3, Fig. 9.
1999 *Panderodus unicostatus* (BRANSON & MEHL) – COCKLE, p. 120; Pl. 5, Figs. 1–8.
2003 *Panderodus unicostatus* (BRANSON & MEHL) – FARRELL, p. 122; Pl. 1, Figs. 1, 3–5.
2004 *Panderodus unicostatus* (BRANSON & MEHL) – FARRELL, p. 959; Pl. 4, Figs. 10–13.
2005 *Panderodus unicostatus* (BRANSON & MEHL) – TROTTER & TALENT, p. 42; Pl. 18, Figs. 26, 27.
2006 *Panderodus unicostatus* (BRANSON & MEHL) – MATHIESON, p. 26; Pl. 1, Figs. A–E, N–P.

Remarks: Cones are slender possessing a gently curved anterior margin. Some features among the different units of *Panderodus unicostatus* are similar to those of *Panderodus recurvatus*. Both species are discriminated mainly by the degree of curvature of the cusp and its shape (BARRICK, 1977). Elements of *Panderodus unicostatus* show a gently curved, uniformly tapering anterior margin from the base to the tip of the cusp, whereas the cusp of *Panderodus recurvatus* is strongly recurved and distally flattened.
BARRICK (1977) assumed a quadrimembrate concept for the coniform apparatus consisting of Sa, Sb, Sc and M elements. A history on diverse mulitelement reconstructions of *Panderodus*, from bi to nonimembrate apparatuses is presented in SANSOM et al. (1994). They concluded an architectural model consisting of qa (arcuatiform), qg (asymmetrical graciliform and sub-symmetrical graciliform), qt (truncatiform), ae (aequaliform), pf (falciform), and pt (tortiform) elements. The ascertained position and distinctive shape of units (cusp curvature and cross-section) was improved by them mainly from investigation of a bedding plane assemblage, clusters of *Panderodus unicostatus*, and collections of isolated cones.

Panderodus sp.

Pl. 5, Figs. 7–9, 15; Pl. 6, Fig. 8

Material: 888 specimens.

Remarks: Specimens unlike those of *Panderodus recurvatus* and *Panderodus unicostatus* are included here. Some of them are very fragile and slender (Plate 6, Fig. 8), possessing a rather straight anterior margin, curved in posterior direction in the upper third. A groove is present in the posterior quarter and extends to the base of the cusp, where it disappears. The cusp is untwisted and has a nearly circular cross-section.

Order: Prioniodontida DZIK, 1976
Family: Icriodellidae SWEET, 1988
Genus: *Pedavis* KLAPPER & PHILIPP, 1971

Type species: *Icriodus pesavis* BISCHOFF & SANNEMANN, 1958.

Pedavis sp.

Pl. 7, Fig. 10; Pl. 9, Figs. 9–13

General Remarks: No I elements of *Pedavis*, which would provide a proper assignment at the level of a species, were obtained from any sample. Therefore all obtained specimens (M2b, M2c and M2d elements) were bulked as *Pedavis* sp., although they might belong to different species. Listings below each element include *Pedavis breviramus, Pedavis* ? *disparaxilis, Pedavis mariannae, Pedavis pesavis* and several types of *Pedavis* sp. in open nomenclature, to demonstrate a spectrum of differing types occurring in Lochkovian and Pragian strata, which nevertheless bear some similarity to the obtained material. Especially M2d elements show a wide range in shape and surface texture within one species; distinctive specific features among these are rare. Most of the elements found occur within a short interval, starting a few metres above the last occurrence of *Ancyrodelloides transitans* and *Flajsella stygia* (regarded as upper part of the *delta* Zone) and range close below the base of the megaclast horizon (base of the *steinachensis* Zone). Two more, but terribly preserved elements were obtained from a megaclast (Se/02/17/04) of the succeeding horizon.

Material: 50 specimens.

M2b element (Pl. 9, Fig. 13)

1958 *Scolopodus devonicus* n. sp. BISCHOFF & SANNEMANN, p. 103; Pl. 15, Fig. 19.
1983 *Pedavis* sp. MURPHY & MATTI, Pl. 7, Figs. 21, 28; Text-Fig. 8.
?1983 *Pedavis breviramus* n. sp. MURPHY & MATTI, p. 55; Pl. 8, Fig. 13; Text-Fig. 8.
1989 *Pedavis ? disparaxilis* n. sp. WILSON, p. 124; Pl. 3, Figs. 19, 20; Pl. 4, Figs. 5–7, 11.
1989 *Pedavis* n. sp. B KLAPPER & PHILIP – WILSON, p. 133; Pl. 4, Fig. 21.

Description: The element has a higher cusp anterior and a small denticle (fragmented tip) posterior. The basal part is slightly fragmented, but seems to outline an irregular oval cross-section. The anterior margin is rather straight. The entire surface is covered with regularly spaced costae parallel to the anterior margin.

M2c element

?1958 *Scolopodus devonicus* n. sp. BISCHOFF & SANNEMANN, p. 103; Pl. 15, Fig. 19.
1980b *Pedavis* sp. SCHÖNLAUB, Pl. 7, Figs. 23?, 25.
1983 *Pedavis* sp. MURPHY & MATTI, Pl. 7, Figs. 22–24, 27; Text-Fig. 8.
1983 *Pedavis breviramus* n. sp. MURPHY & MATTI, p. 55; Pl. 8, Fig. 15; Text-Fig. 8.
1989 *Pedavis ? disparaxilis* n. sp. WILSON, p. 124; Pl. 3, Figs. 5, 26.

Remarks: The obtained specimens have a strongly curved cusp possessing few prominent costae along the posterior lateral surface. The basal cavity is very deep, extending towards the tip of the cusp. According to the degree of curvature of the anterior margin and the presence of costae the element is similar to a specimen illustrated by WILSON (1989).

M2d element (Pl. 7, Fig. 10; Pl. 9, Figs. 9–12)

1975 *Scolopodus erectus* sp. nov. TELFORD, p. 55; Pl. 10, Figs. 2?, 3?, 4, 6?, 7.
1980 *Pedavis* sp. CHLUPÁČ, KŘÍŽ & SCHÖNLAUB, Pl. 91, Fig. 5.
1980b *Pedavis* sp. SCHÖNLAUB, Pl. 4, Fig. 19.
1983 *Pedavis* sp. MURPHY & MATTI, Pl. 7, Figs. 16–19, 25, 26; Text-Fig. 8.
1989 *Pedavis pesavis* (BISCHOFF & SANNEMANN) – SORENTINO, p. 85; Pl. 5, Fig. 17.
1989 *Pedavis ? disparaxilis* n. sp. WILSON, p. 124; Pl. 3, Figs. 6–12, 21–25, 27; Pl. 4, Figs. 8, 9, 15–18.
1989 *Pedavis* n. sp. B KLAPPER & PHILIP – WILSON, p. 133; Pl. 4, Fig. 14.
1995 *Pedavis* sp. CAREY & BOLGER, p. 81; Fig. 4B.
1998 *Pedavis* sp. KOZUR, Pl. 1, Fig. 10.
1999 *Pedavis mariannae* LANE & ORMISTON – TALENT & MAWSON, Pl. 5, Fig. 8.

Description: Simple cones differing in height, density of costae, extent of the basal cavity and shape of the base. Some have a wider conical base compared to a rounded, more bulging base of others. The cusp and base form one continuous, gently curved anterior margin. The posterior margin is bulge-like, curved towards the base of the cusp. The posterior margin of the cusp is rather straight, gently tapering distally. Some elements differ in the degree of inclination of the anterior margin. The cross-section of the lower margin is circular to slightly compressed. The surface is covered with a few prominent and regularly spaced costae (e.g.: Plate 9, Figs. 10 and 12) or a few almost regularly spaced costae including a small one on the posterior lateral face at an angle to the adjacent posterior costa, extending only as high as the base (Plate 9, Fig. 9). It remains unclear whether this represents a distinct feature or only ontogenetic growth pattern. Another type bears a few regularly spaced, but slightly twisted costae possessing fine longitudinal striae covering the entire costate surface (Plate 9, Fig. 11). The element illustrated on Plate 7, Fig. 10, exhibits few, but less prominent costae and some fine longitudinal striae of irregular(?) distribution around the cone, although the surface is poorly preserved. Among all elements observed, costae extend only to the upper part of the base. The base itself is uncostate.

Remarks: Due to the small number of cones and the lack of corresponding I elements, the distinction of surface ornament for proper assignment to a species remains unclear. The fragmented cone (Plate 9, Fig. 9) comes close to that figured by SCHÖNLAUB (1980b). The density of costae within the columnar texture around the cone is nearly the same according to the space interval. The gently curved anterior margin and pronounced bulged base in the lower quarter of the posterior margin are almost identical. Another element illustrated (Plate 7, Fig. 10) is similar in shape of curvature of the anterior margin and in possessing finer parallel costae to the M2d element assigned to *Pedavis mariannae* by TALENT & MAWSON (1999).

Family: Icriodontidae MÜLLER & MÜLLER, 1957
Genus: *Caudicriodus* BULTYNCK, 1976

Type species: *Icriodus woschmidti* ZIEGLER, 1960.

Caudicriodus aff. *C. celtibericus* (CARLS & GANDL, 1969)

Pl. 9, Fig. 4

Material: 1 specimen.

I element (Pl. 9, Fig. 4)

aff. 1969 *Icriodus huddlei celtibericus* n. ssp. CARLS & GANDL, p. 182; Pl. 16, Fig. 20, non Figs. 18, 19.
aff. 1975 *Icriodus huddlei* (KLAPPER & ZIEGLER) – KLAPPER, LINDSTRÖM, SWEET & ZIEGLER, p. 117; Pl. 4, Figs. 2, 3, non Figs. 1, 4.
non aff. 1980 *Caudicriodus celtibericus* subsp. A BULTYNCK & HOLLARD, p. 38; Pl. 1, Fig. 25.
aff. 1980 *Icriodus celtibericus* CARLS & GANDL – KLAPPER & JOHNSON, Pl. 2, Figs. 12, 17.
non aff. 1985 *Icriodus huddlei ? celtibericus* (CARLS & GANDL) – AUSTIN, ORCHARD & STEWART, Pl. 4.1, Fig. 7.
aff. 1995 *Caudicriodus celtibericus* (CARLS & GANDL) – KALVODA, p. 35; Pl. 1, Fig. 11, non Figs. 5, 9; Pl. 2, Figs. 1, 4 [cum syn.].
aff. 1999 *Caudicriodus celtibericus* (CARLS & GANDL) – BENFRIKA, p. 318; Pl. 1, Fig. 12.
aff. 2003 *Icriodus celtibericus* CARLS & GANDL – MAWSON, TALENT, MOLLOY & SIMPSON, Pl. 5, Figs. 15–18.
aff. 2004a *Caudicriodus celtibericus* (CARLS & GANDL) – SLAVÍK, Figs. 11.1–11.3.
aff. 2004b *Caudicriodus celtibericus* (CARLS & GANDL) – SLAVÍK, Pl. 1, Figs. 7, 8.
aff. 2006 *Icriodus* sp. aff. *I. celtibericus* (CARLS & GANDL) – MATHIESON, p. 31; Pl. 3, Figs. N–R.

Description: The axis of the figured I element is slightly arched in upper view with the anterior immature denticle and the posterior primary cusp pointing inward. The basal cavity is V-shaped and opens between the fourth and fifth mature transverse row on the inner side (outer side not preserved). The margin of the outer platform spur is rather small with subcircular outline. It covers only about one-quarter of the element's entire length. Unfortunately, the most important feature, the lateral process is broken. The anterior immature denticle and the next two transverse rows are spaced equally, but spaces are twice as long as that between the three most posterior denticle rows. Denticles of transverse rows are almost aligned, except the median denticle of the posteriormost transverse row, set somewhat anterior so that the row points slightly anteriorly. The second to fifth denticle rows seem to be of equal width (estimated on the preserved median and inner longitudinal rows that possess equal narrow distances between denticles of each transverse row in upper view). Longitudinal rows are almost of equal height. Denticles of the outer longitudinal rows are of blunt rounded shape, whereas those of the median row are rounded to subsquare. The secondary cusp is laterally compressed and slightly lower in height than the median denticle of the fifth transverse row. Contrastingly the primary cusp is little higher than all other denticles. The I element's surface is strongly remineralized and hence, no primary ornament can be recognized. For morphometric data see Table 1.

Remarks: The obtained specimen differs from the original description in possessing only 5 transverse denticle rows, instead of 6–9. Due to the fractured lateral process, length and degree of curvature cannot be determined. Nevertheless the remainder of the most proximal part, connecting the lateral process and primary cusp, is preserved on the outer side of the figured specimen. It seems to have a short almost rectangular junction. This appendage at the junction apparently reflects the remainder of a stepped process. This would correspond to the original description of CARLS & GANDL (1969), where it is proposed as distinct feature discriminating *Caudicriodus celtibericus* from its ancestor *Caudicriodus curvicauda*, that developed a short lateral process bending more gradually.

? *Caudicriodus* sp.

Pl. 9, Fig. 7;

Material: 5 specimens.

I element (Pl. 9, Fig. 7)

Description: Figured is a juvenile specimen with a nearly straight platform axis, only slightly arched at the anteriormost part. Three mature transverse denticle rows are preserved. The immature denticle row as well as the primary cusp and the lateral process is broken. Lateral margins of the spindle have a parallel outline. At maximum width, the platform is almost as wide as the transverse row. Denticles of transverse rows stand in line except those of the posteriormost row. Denticles are conical. The median row seems elevated. The secondary cusp is little higher than denticles of the median row and has a triangular shape in lateral view. For morphometric data see Table 1.

Remarks: Due to the broken lateral process and the obtained elements being juveniles, the specimens could belong either to *Caudicriodus curvicauda* or *C. celtibericus*. Another specimen, assigned to ? *Caudicriodus* sp., shows similar features. Taking into account immaturity of elements and the high degree of breakage, a reliable determination is impossible.

Genus: *Icriodus* BRANSON & MEHL, 1938

Type species: *Icriodus expansus* BRANSON & MEHL, 1938.

Icriodus sp.

Pl. 6, Figs. 10, 15

Material: 10 specimens.

Adenticulate S element (Pl. 6, Fig. 10)

aff. 1960 *Paltodus* sp. a ZIEGLER, p. 190; Pl. 13, Fig. 6.

aff. 1983 *Icriodus woschmidti woschmidti* ZIEGLER – SERPAGLI, p. 155; Figs. 2, 4J–R, 6f, 7J, 7K.

Remarks: Elements are similar to those presented in ZIEGLER (1960). They differ mainly in possessing a more strongly curved cusp. The basal margin is asymmetrical, with a centred oval part and an extremely wide keel. The upper two-thirds of the posterior surface of the cone is covered with fine striae, whilst the base remains smooth. Compared to the material of SERPAGLI (1983), elements come close to the ϕ morphotype.

Adenticulate M2 element

aff. 1983 *Icriodus woschmidti woschmidti* ZIEGLER – SERPAGLI, p. 155; Figs. 4A–I, 6e, 7H, 7I.

Remarks: Cones have an oval to more circular outline of the basal margin. The cusp is erect and unornamented. Some specimens are similar to those illustrated by SERPAGLI (1983), grouped within the second transition series as ϵ morphotype.

Denticulate M2 element (Pl. 6, Fig. 15)

aff. 1983 *Icriodus woschmidti woschmidti* ZIEGLER – SERPAGLI, p. 155; Figs. 2, 3A–F, 6a, 7A, 7B.

Remarks: The element is cordylodiform, possessing a short (uni-)denticulate posterior process. The basal margin is slightly asymmetrical. No surface texture is observed. Excepting the curvature of the cusp, it is very close to the α morphotype of *Icriodus woschmidti woschmidti* (Fig. 7A in SERPAGLI, 1983). Only one specimen was obtained from the lowermost part of the Seewarte section (Se/01/03/04).

Genus: *Latericriodus* MÜLLER, 1962

Type species: *Icriodus latericre scens* BRANSON & MEHL, 1938.

Latericriodus cf. *L. steinachensis* (AL-RAWI, 1977) beta morph KLAPPER & JOHNSON, 1980

Pl. 8, Fig. 1

Material: 1 specimen.

I element (Pl. 8, Fig. 1)

cf. 1977 *Icriodus steinachensis* n. sp. AL-RAWI, p. 55; Pl. 5, Fig. 43.

cf. 1979 *Icriodus steinachensis* AL-RAWI – LANE & ORMISTON, p. 54; Pl. 4, Figs. 28, 29.

cf. 1980 *Icriodus steinachensis* AL-RAWI beta morphotype – KLAPPER & JOHNSON, Pl. 2, Figs. 19–22.

cf. 1980b *Icriodus* cf. *steinachensis* AL-RAWI – SCHÖNLAUB, p. 41; Pl. 5, Fig. 20; Pl. 6, Figs. 15, 16.

cf. 1983 *Icriodus steinachensis* AL-RAWI beta morph KLAPPER & JOHNSON – MURPHY & MATTI, p. 58; Pl. 5, Fig. 31, Text-Fig. 10.

cf. 1984 *Icriodus steinachensis* AL-RAWI – MURPHY & CEBECIOĞLU, Fig. 2 – A, C, H, Z, BB, CC, EE–HH; Fig. 5 – G–J, N–P.

cf. 1985 *Icriodus steinachensis* AL-RAWI beta morphotype – CHLUPÁČ, LUKEŠ, PARIS & SCHÖNLAUB, p. 27; Pl. 2, Fig. 4.

cf. 1985b *Icriodus steinachensis* AL-RAWI morphotype beta KLAPPER & JOHNSON – MASTANDREA, p. 264; Pl. 1, Fig. 7?

cf. 1985b *Icriodus steinachensis* AL-RAWI beta morphotype – SCHÖNLAUB, Pl. 3, Fig. 4?

cf. 1986 *Icriodus steinachensis* AL-RAWI – CEBECIOĞLU & MURPHY, Pl. 1, Fig. 1–3, 5–7, 34, 36 [= specimen Fig. 5 – G–I, N–P; Fig. 2 – A, C; respectively; MURPHY & CEBECIOĞLU, 1984].

cf. 1991 *Icriodus steinachensis* AL-RAWI beta morphotype sensu KLAPPER (in KLAPPER & JOHNSON) – UYENO, Pl. 1, Fig. 11.

cf. 1992 *Icriodus steinachensis* AL-RAWI – BARDASHEV & ZIEGLER, Pl. 3, Figs. 17?, 19.

cf. 1994a *Icriodus steinachensis* AL-RAWI – VALENZUELA-RÍOS, p. 89; lam. 8, Figs. 1, 5–7.

cf. 2003 *Icriodus* cf. *I. steinachensis* KLAPPER & JOHNSON – PYLE, ORCHARD, BARNES & LANDRY, Pl. 1, Fig. 7?

cf. 2004b *Latericriodus steinachensis* (AL-RAWI) beta morphotype KLAPPER & JOHNSON – SLAVÍK, Pl. 1, Fig. 4.
cf. 2004 *Latericriodus steinachensis* (AL-RAWI) beta morph KLAPPER & JOHNSON – SLAVÍK & HLADIL, p. 145; Pl. 1, Fig. 1.

Description: Only one specimen with broken posterior part was obtained. The outline of the spindle seems rather triangular with its maximum width located at the posteriormost transverse denticle-row preserved. The platform axis seems more straight than arched. Denticles of the lateral rows are longitudinally compressed, elliptical to oval, and twice in size those of the median row of cross-section. Denticles of the median row are rounded to subsquare in cross-section. They are connected by a transverse bar-like junction to the lateral denticles of each multidenticle row, becoming smaller towards the posterior end. (For morphometric data see Table 1).

Remarks: As the posteriormost part of the specimen is fractured, it cannot be assigned to the beta morph with certainty, although the remaining outline of the spindle clearly shows a triangular shape (= the distinctive feature for the beta morph). Taking in account the estimated elongation measured from the broken specimen, a ratio a little below 54 could be reached, even if the element had a quarter of its original entire length at the same width (330 μm). Compared to Fig. 6 in MURPHY & CEBECIOĞLU (1984), the elongation index of the beta morph ranges approximately between 53 and 60.

Latericriodus steinachensis (AL-RAWI, 1977) eta morph KLAPPER & JOHNSON, 1980

Pl. 8, Figs. 2, 8–10; Pl. 9, Figs. 1, 5, 6, 8

Material: 10 specimens.

I element (Pl. 8, Figs. 2, 8–10; Pl. 9, Figs. 1, 5, 6, 8)

1958 *Icriodus latericrescens latericrescens* BRANSON & MEHL – BISCHOFF & SANNEMANN, p. 95; Pl. 12, Fig. 8?
1971 *Icriodus latericrescens* BRANSON & MEHL – KLAPPER & PHILIP, Fig. 8.
1977 *Icriodus steinachensis* n. sp. AL-RAWI, p. 55; Pl. 5, Fig. 42.
1980 *Icriodus* cf. *steinachensis* AL-RAWI – CHLUPÁČ, KŘÍŽ & SCHÖNLAUB, p. 160; Pl. 23, Fig. 1.
1980 *Icriodus steinachensis* AL-RAWI eta morphotype – KLAPPER & JOHNSON, Pl. 2, Figs. 25–27.
1980b *Icriodus* cf. *steinachensis* AL-RAWI – SCHÖNLAUB, p. 41; Pl. 6, Figs. 14, 17; Pl. 7, Figs. 20, 21.
1981 *Icriodus steinachensis* AL-RAWI eta morphotype – JOHNSON & KLAPPER, p. 1241; Pl. 1, Figs. 13–16, 18, 19 [18, 19 = Pl. 2, Fig. 25, KLAPPER & JOHNSON, 1980].
1983 *Icriodus steinachensis* AL-RAWI eta morph KLAPPER & JOHNSON – MURPHY & MATTI, p. 58; Pl. 5, Fig. 36, Text-Fig. 10.
1984 *Icriodus steinachensis* AL-RAWI – MURPHY & CEBECIOĞLU, Fig. 2 (B, D–F, K–R); Fig. 5 (K–M, Q).
1985 *Icriodus steinachensis* AL-RAWI eta morphotype – CHLUPÁČ, LUKEŠ, PARIS & SCHÖNLAUB, p. 27; Pl. 2, Figs. 5, 13–16.
1985b *Icriodus steinachensis* AL-RAWI morphotype beta KLAPPER & JOHNSON – MASTANDREA, p. 264; Pl. 1, Figs. 8, 9.
1985b *Icriodus steinachensis* AL-RAWI eta morphotype – SCHÖNLAUB, Pl. 3, Fig. 3.
1986 *Icriodus steinachensis* AL-RAWI – CEBECIOĞLU & MURPHY, Pl. 1, Fig. 4, 8, 22–26, 35, 37–39 [= specimen Fig. 5 (K, Q); Fig. 2 (O, K, M, Q, R, B, D–F respectively); MURPHY & CEBECIOĞLU, 1984].
1992 *Icriodus steinachensis* AL-RAWI – BARDASHEV & ZIEGLER, Pl. 3, Figs. 15, 18?, 22?
1994 *Icriodus steinachensis* AL-RAWI eta morph KLAPPER & JOHNSON – MAWSON & TALENT, p. 47; Fig. 9 (K–N).
1994a *Icriodus steinachensis* AL-RAWI – VALENZUELA-RÍOS, p. 89; lam. 8, Figs. 2, 3, 8, 11.
1999 *Latericriodus steinachensis (*AL-RAWI) – BENFRIKA, p. 318; Pl. 1, Fig. 15.
1999 *Icriodus steinachensis* AL-RAWI eta morph – TALENT & MAWSON, p. 73; Pl. 4, Fig. 6?; Pl. 7, Figs. 5, 6; Pl. 12, Fig. 17.
2003 *Icriodus* cf. *I. steinachensis* AL-RAWI eta morphotype KLAPPER & JOHNSON – FARRELL, p. 125; Pl. 2, Fig. 3?
2004b *Latericriodus steinachensis* (AL-RAWI) eta morphotype KLAPPER & JOHNSON – SLAVÍK, Pl. 1, Fig. 5.
2004 *Latericriodus steinachensis* (AL-RAWI) eta morph KLAPPER & JOHNSON – SLAVÍK & HLADIL, p. 144; Pl. 1, Figs. 2–4.

Description: Elements have a deeply V-shaped basal cavity, with an arched axis pointing inward. At maximum width, unbroken I elements exhibit a ratio of basal cavity width to spindle width around 2:1 up to 2.5:1. The outline of the spindle is lenticular with its maximum width located approximately at middle length (= a distinctive feature of the eta morph). The lateral process bears three equally sized and spaced denticles including an angle of 88–114 degrees to the main process. The inner margin of the lateral process tapers towards half the length of the platform, but usually the marginal parts of the process and the platform are broken in the obtained material. The spur sometimes bears a thin linear ridge which joins the platform between the first and second posteriormost transverse denticle rows at a more or less acute angle (compare Plate 8, Figs. 8b and 9; Appendix 3). Denticles of the median and lateral rows are aligned. The posteriormost transverse row only possesses an unaligned median denticle. In this case the transverse row distinctively points anteriorly (including an angle of 130–150 degrees) in upper view. Denticles of the lateral longitudinal rows generally have blunt to acuminate tips. Denticles of the median row show rounded to subangular tips. A few specimens show slightly smaller denticles of the median row (in cross-section and height) compared to those of lateral rows. Between the posteriormost denticle of the median row and the secondary cusp is a smaller and lower node, almost half the size of the cusp. Furthermore the length between the posteriormost median denticle and the primary cusp has a straight to slightly sigmoidal outline in upper view (compare Plate 9, Fig. 6a). Both cusps look like two rounded to nearly triangular ridges in lateral view. Neither denticles, nor the platform surface is ornamented. For morphometric data see Table 1.

Remarks: The elongation index (MURPHY & CEBECIOĞLU, 1984) of measured unbroken specimens ranges between 59–74; this clearly discriminates *L. steinachensis* eta from the beta morphotype, and from the closely related *L. claudiae*. Contrary to the beta morph, the eta morph enters not exclusively at the *pesavis/sulcatus* boundary, but earlier, in the upper *delta* Zone in Nevada (MURPHY & MATTI, 1983; MURPHY & BERRY, 1983: Fig. 2). In Barrandian sections (SLAVÍK, 2004b; SLAVÍK & HLADIL, 2004), Austria (SCHÖNLAUB, 1980b), Morocco (BENFRIKA, 1999) and Australia (MAWSON & TALENT, 1994) the eta morph occurs close to the Lochkovian-Pragian boundary. Following MURPHY & MATTI (1983), both *L. steinachensis* morphotypes seem to disappear in the lower *kindlei* Zone. In the Seewarte section the last occurrence of the eta morph is documented in the *celtibericus* Zone (Upper Pragian).

Latericriodus cf. *L. steinachensis* (AL-RAWI, 1977) eta morph KLAPPER & JOHNSON, 1980

Pl. 7, Fig. 7; Pl. 8, Figs. 3, 5, 6, 7; Pl. 9, Figs. 2, 3

Material: 8 specimens.

M2 element (Pl. 7, Fig. 7)

aff. 1985b *Icriodus steinachensis* AL-RAWI morphotype beta KLAPPER & JOHNSON – MASTANDREA, p. 264; Pl. 1, Fig. 11.

Description: A simple cone with circular cross-section of the basal margin. The lower margin is slightly undulating in lateral view. The base has a low, angular conical shape tapering into a straight cusp. The basal cavity is

Table 1.
Morphometric data on I elements of icriodontid specimens.
Inv. no. = inventory number; angle lat. proc. = angle of the lateral process; adult tr.v. rows = adult transverse rows; transv. broken = transversally broken almost along the median row; juv. sp. = juvenile specimen.

specimen (I element)	sample	Inv. no.	length (µm)	width (µm)	ratio (1-W/L)	angle lat. proc.	adult tr.v. rows
Latericriodus cf. *L. steinachensis* beta morph	Se/02/15b/05	GBA-2006/1/13-03	> 570 (broken)	> 330		broken	5 (broken)
Latericriodus steinachensis eta morph	Se/02/15b/05	GBA-2006/1/13-01	590	175	0,7	broken	4
Latericriodus cf. *L. steinachensis* eta morph	Se/02/15b/05	GBA-2006/1/13-02	> 470 (broken)	> 210 (broken)		88	2 (broken)
Latericriodus cf. *L. steinachensis* eta morph	Se/02/15b/05	GBA-2006/1/SE 039	> 500 (broken)	200		broken	5
Latericriodus steinachensis eta morph	Se/02/15c/05	GBA-2006/1/13-04	990	334	0,66	broken	6
Latericriodus steinachensis eta morph	Se/02/15c/05	GBA-2006/1/SE 040	> 680 (broken)	330		broken	5
? *Latericriodus* sp.	Se/02/30/04	GBA-2006/1/SE 055	180	90		broken	2 (juv. sp.)
Latericriodus aff. *L. steinachensis* eta morph	Se/02/30a/05	GBA-2006/1/SE 056	530	200	0,62	broken	4
Latericriodus steinachensis eta morph	Se/02/31/04	GBA-2006/1/08-17	550	200	0,64	92 ?	4
? *Latericriodus* sp.	Se/02/33/04	GBA-2006/1/13-05	440	171	0,61	broken	4 (juv. sp.)
Latericriodus steinachensis eta morph (3 pieces)	Se/02/40/04	GBA-2006/1/SE 065	570	190	0,67	broken	5
Latericriodus cf. *L. steinachensis* eta morph	Se/03/02/04	GBA-2006/1/10-43	> 520 (broken)	230		broken	4
Latericriodus cf. *L. steinachensis* eta morph	Se/03/05/04	GBA-2006/1/13-06	> 690 (broken)	272		broken	8 (broken)
Latericriodus cf. *L. steinachensis* eta morph	Se/03/05/04	GBA-2006/1/13-07	> 580 (broken)	260		broken	5 ?
? *Caudicriodus* sp.	Se/03/12/04	GBA-2006/1/SE 078	> 280 (broken)	110		broken	4 (broken)
Latericriodus steinachensis eta morph	Se/03/13/04	GBA-2006/1/08-21	> 650 (broken)	225		broken	6
? *Caudicriodus* sp.	Se/03/14/04	GBA-2006/1/13-08	> 310 (broken)	> 108 (broken)		broken	3 (juv. sp.)
Latericriodus steinachensis eta morph	Se/03/22/04	GBA-2006/1/08-25	650	169	0,74	100	-
Latericriodus cf. *L. steinachensis* eta morph	Se/03/24/04	GBA-2006/1/13-18	> 415 (broken)	181		broken	4
Latericriodus steinachensis eta morph	Se/03/24/04	GBA-2006/1/13-19	> 660 (broken)	256		84	5 (broken)
Latericriodus aff. *L. steinachensis* eta morph	Se/03/24/04	GBA-2006/1/SE 090	> 360 (broken)	150		broken	4
? *Caudicriodus* sp.	Se/03/24/04	GBA-2006/1/SE 090	> 140 (broken)	100		broken	3
fragmented Icriodontidae (2 lat. rows)	Se/03/24/04	GBA-2006/1/SE 090	> 250 (broken)	transv. broken		broken	4
Latericriodus aff. *L. steinachensis* (2 lat. rows)	Se/03/24/04	GBA-2006/1/SE 090	380	transv. broken		broken	4
Latericriodus steinachensis eta morph	Se/03/29/04	GBA-2006/1/13-21	575	151	0,74	114	5
? *Caudicriodus* sp.	Se/03/29/04	GBA-2006/1/SE 095	> 220 (broken)	100		broken	3
Latericriodus cf. *L. steinachensis* eta morph	Se/03/37/04	GBA-2006/1/13-23	> 405 (broken)	147		broken	4
Latericriodus aff. *L. steinachensis* eta morph	Se/03/43/04	GBA-2006/1/SE 107	390	160	0,59	broken	4
Caudicriodus aff. *C. celtibericus*	Se/03/45/05	GBA-2006/1/13-24	610	> 162 (broken)		91 ?	5
Latericriodus steinachensis eta morph	Se/04/-07/04	GBA-2006/1/13-30	> 460 (broken)	145		91	4 ?

restricted to the element's unornamented base. The almost cylindrical cusp possesses about 12 prominent equally-spaced striae and is very similar to the shape of a Greek column.

Remarks: The unsculptured basal margin is somewhat higher and circular rather than elliptical in cross-section of the figured specimen compared to the beta morph of MASTANDREA (1985b). All other features are nearly identical. As this specimen was obtained from a level below the first occurrence of icriodontid elements within the Seewarte section, it may belong to the eta morph, which appears in the latest *delta* Zone. According to MURPHY & MATTI (1983) the eta morph enters in the late *delta* Zone.

I element (Pl. 8, Figs. 3, 5, 6, 7; Pl. 9, Figs. 2, 3)

Remarks: Some specimens have a major part of the lateral process broken off, which makes a proper assignment difficult. Other I elements (e.g.: Plate 8, Fig. 7), with the anterior part broken, have the lateral process preserved, so that at least the angle to the main process is measurable (Table 1).

Latericriodus aff. *L. steinachensis* (AL-RAWI, 1977) eta morph KLAPPER & JOHNSON, 1980

Material: 4 specimens.

I element

Remarks: Specimens that are very similar to the eta morph, but lack most of the diagnostic features are gathered here.

? *Latericriodus* sp.

Pl. 8, Fig. 4

Material: 19 specimens.

I element (Pl. 8, Fig. 4)

Description: The outline of the figured specimen shows a spindle that is almost triangular except that the posteriormost two transverse denticle rows preserved are of equal width. The platform axis is straight. The lateral process as well as the main part of the spur are not preserved. Denticles are rather high and have a circular cross-section and blunt tips. Denticles of the lateral rows are of equal height to those of the median row with relatively broad spaces between each other longitudinally and transversely (for morphometric data see Table 1).

Remarks: The obtained juvenile specimen differs from those assigned to ? *Caudicriodus* sp. in the outline of the spindle and in shape, height and spacing of denticles. Because of immaturity of the elements no further discrimination at species-level can be undertaken. Other elements, identified as ? *Latericriodus* sp., are assigned to the genus only, because of the high degree of breakage.

Genus: *Pelekysgnathus* THOMAS, 1949

Type species: *Pelekysgnathus inclinata* THOMAS, 1949.

Pelekysgnathus sp.

Pl. 11, Fig. 15

Material: 9 specimens.

S element (Pl. 11, Fig. 15)

Description: Simple cones exhibiting a subcircular to lenticular basal margin. The cusp, usually laterally flattened, is erect and in some specimens inclined. The surface remains unornamented or is finely striate.

Remarks: No I elements were obtained, so that specific identification is not possible.

Order: Prioniodinida SWEET, 1988
Family: Prioniodinidae BASSLER, 1925
Genus: *Oulodus* BRANSON & MEHL, 1933

Type species: *Cordylodus serratus* STAUFFER, 1930.

Oulodus aclys MAWSON, 1986

Pl. 10, Figs. 12, 13; Pl. 11, Figs. 2, 4, 5

Material: 56 specimens.

Sb element (Pl. 10, Figs. 12, 13)

1986 *Oulodus aclys* n. sp. MAWSON, p. 47; Pl. 2, Figs. 12–14.
1989 *Oulodus aclys* MAWSON – SORENTINO, p. 89; Pl. 6, Fig. 13.
1989 *Oulodus aclys* MAWSON – WILSON, p. 134; Pl. 7, Figs. 5?, 7.
1999 *Oulodus aclys* MAWSON – TALENT & MAWSON, Pl. 7, Fig. 20.

Description: The anterior process bears four to six discrete, equally spaced denticles. The posterior process of the illustrated elements is broken but possesses two (Fig. 13) and four (Fig. 12) denticles. Usually it has five denticles developed. Denticles are wide at the base tapering to a point distally. The cusp is curved, pointing to the inner side. The cross-section of denticles and cusp is subcircular. Lateral processes join the cusp on the outer side. The lower margin is bent including an angle of 85–100 degrees. The basal cavity extends widely on the inner side; it has a lip-like, rounded margin. The basal pit is deep and located beneath the cusp. Basal grooves are shallow and wide proximally, tapering to the distal end.

Sc element (Pl. 11, Fig. 2)

1971 ? *Ligonodina salopia* RHODES – FÅHRAEUS, p. 675; Pl. 78, Fig. 43.
1986 *Oulodus aclys* n. sp. MAWSON, p. 47; Pl. 2, Figs. 15–16.
1989 *Oulodus aclys* MAWSON – SORENTINO, p. 89; Pl. 6, Fig. 12.
1989 *Oulodus aclys* MAWSON – WILSON, p. 134; Pl. 7, Fig. 6?
1999 *Oulodus aclys* MAWSON – TALENT & MAWSON, Pl. 6, Figs. 1, 2.
2003 *Oulodus aclys* MAWSON – FARRELL, p. 126; Pl. 3, Figs. 3, 5.

Description: A robust element with the anterior process bent downward. Denticles on either processes are discrete and closely spaced. Though strongly broken, they show a broad base with a nearly circular cross-section. Denticles and cusp tend to point to the posterior end. The basal cavity is shallow beneath the cusp. Basal grooves are strongly inverted along either process.

Pa element (Pl. 11, Figs. 4, 5)

1986 *Oulodus aclys* n. sp. MAWSON, p. 47; Pl. 2, Figs. 1–3.
1989 *Oulodus aclys* MAWSON – SORENTINO, p. 89; Pl. 6, Fig. 10.
1989 *Oulodus aclys* MAWSON – WILSON, p. 134; Pl. 7, Figs. 1, 2.

Description: The illustrated Pa elements have partially broken processes and one of them a strongly broken cusp. The cusp and denticles have a subcircular cross-section. The remaining denticles of the posterior process are narrow in one and equally spaced in the other specimen. They taper to a point distally at a more acute angle, so the space between the denticles is more V- than U-shaped. The prominent cusp tends to curve slightly to the posterior distally (as far as preserved) with the posterior process joining the cusp subcentrally, not in precise central axial alignment, with the outer margin of the cusp in upper view. The basal cavity is rounded, widening towards the inner side. In contrast to the wide, shallow basal cavity, the basal pit is small and located beneath the cusp. The basal grooves are shallow proximally and located closer to the outer margin than the central axial position in lower view. The basal margin is arched, usually including an angle of 90–100 degrees, though not clearly estimable from the figured specimens due to the highly broken anterior process.

Oulodus elegans detorta (WALLISER, 1964)

Pl. 10, Figs. 1, 8; Pl. 11, Fig. 3

General Remarks: Elements of *Oulodus elegans detorta* can be distinguished easily from *Oulodus elegans elegans* by the appearance of one or two very small denticles in the spaces between normal-sized denticles (JEPPSSON, 1989). Elements of *Oul. e. elegans* lack distinct small denticles and bear denticles of “normal”-size increasing evenly in height distally. Elements identified as *Ligonodina elegans* (WALLISER, 1964: Plate 32, Figs. 19–21) and *Oulodus elegans* (SWEET & SCHÖNLAUB, 1975) were assigned to *Oulodus greilingi spinosus* in MAWSON (1986), according to the discriminative fragile, thorn-like shape of the denticles. Among all subspecies mentioned (including *Oul. greilingi hirpex*) the most reliable features are the shape and pattern of denticulation.

Material: 9 specimens.

Sa element (Pl. 10, Fig. 8)

1989 *Ligonodina elegans detorta* (WALLISER) – JEPPSSON, p. 26; Pl. 3, Fig. 2.

Description: The figured element seems to have asymmetrical processes. The better preserved one bears seven normal-sized and three very small denticles. Two of the small denticles are located proximally, each between two larger denticles (visible in Fig. 8b: area of the two nearly complete normal-sized denticles) and one in the terminal position. The cusp is twice as high as normal-sized denticles. It is laterally compressed and extends wide towards the posterior end. The anterior margin of the cusp is slightly curved, with the tip pointing posteriorly. Both processes are strongly curved downward and slightly inwarded distally, so that the lower margin forms an angle less that 90 degrees. The basal cavity is rather deep, with a flat anterior and a wide, laterally compressed and distally rounded posterior lower margin. Basal grooves remain open towards the distal edges along either process.

Sc element (Pl. 11, Fig. 3)

1989 *Ligonodina elegans detorta* (WALLISER) – JEPPSSON, p. 26; Pl. 3, Fig. 1.

Description: Generally, the element is relatively slender. The anterior process bears two discrete, but wide spaced denticles of normal height. Four denticles of this type are discernible on the posterior process (the proximal two are broken, with only their base remaining). Intercalated are very small denticles showing a pattern varying between larger denticles of: one – two – one – two(?). The distal portion of the posterior process is broken, so that the two distalmost smaller denticles cannot be regarded as probably terminal ones. The cusp is twice the height of normal-sized denticles. Cusp and denticles of the posterior process are slightly curved posteriorly. The lower margin is gently concave.

M element (Pl. 10, Fig. 1)

1975 *Ligonodina elegans* (WALLISER) – JEPPSSON, p. 19; Pl. 3, Fig. 4 [cum syn.].
1989 *Ligonodina elegans detorta* (WALLISER) – JEPPSSON, p. 26; Pl. 3, Fig. 4.

Description: The obtained element consists of a very prominent cusp and a short posterior process. The anterior process is almost inexistent, forming a descending, narrow adpressed keel. The short posterior process bears at least five equally sized and spaced denticles. The cusp is laterally compressed with a lenticular cross-section. The basal cavity is sub-triangular and of moderate depth, possessing a flat outer side and a rounded lower inner margin. The basal grooves are narrow, running distally towards the tip of each process.

Oulodus elegans elegans (WALLISER, 1964)

Pl. 10, Figs. 2, 3, 7

Material: 27 specimens.

Sa element (Pl. 10, Fig. 7)

1975 *Ligonodina elegans* (WALLISER) – JEPPSSON, p. 19; Pl. 3, Fig. 2 [cum syn.].

Description: The nearly symmetrical element shows a large cusp, curved posteriorly. Denticles on either lateral process are equally spaced. They are little shorter proximally, increasing in height distally. Processes bear at least five denticles. The lower margin of either extremity curves continuously downward forming an angle of about 110 degrees. In lower view, the anterior lower margin is gently bowed. The narrow basal cavity has a rounded anterior lower margin. Contrary the posterior lower margin is much wider. Basal grooves are shallow extending towards either margin distally.

M element (Pl. 10, Figs. 2, 3)

1998b *Oulodus elegans elegans* (WALLISER) – CORRADINI, FERRETTI & SERPAGLI, Pl. 3.3.1, Fig. 13.

Remarks: Elements are very similar to those of *Oulodus elegans detorta* as both types possess similar-sized denticles. They differ in possessing more closely-spaced denticles and a smaller basal cavity. Denticles on the posterior process (at least four in number) seem to descend stepwise. It remains unclear whether the smaller outline of the nearly triangular basal cavity is the result of fragmentation of the lower margin or not. The designation is based on the obvious similarity with the element illustrated by CORRADINI et al. (1998b).

Oulodus greilingi hirpex MAWSON, 1986

Pl. 11, Figs. 7, 8

Material: 15 specimens.

Pa element (Pl. 11, Figs. 7, 8)

aff. 1968 *Ozarkodina ortuformis* WALLISER – SCHULZE, p. 204; Pl. 17, Figs. 5, 7.
1986 *Oulodus greilingi hirpex* n. subsp. MAWSON, p. 46; Pl. 1, Figs. 2, 3.
1999 *Oulodus greilingi hirpex* MAWSON – TALENT & MAWSON, Pl. 6, Fig. 11.

Description: The anterior process is broken in both figured elements, missing at least 2 uniformly-spaced denticles. The posterior process bears up to five unequal, discrete denticles, with the proximal ones smaller than all other denticles. The cusp is rather high with its tip pointing to the posterior inner side. Denticles and cusp are subcircular in cross-section. In lower view, processes seem gently twisted distally. Anterior and posterior lower margin includes an angle of about 120 degrees. The margin of the moderately deep basal cavity is slightly asymmetrically rounded below the cusp, tapering as open basal grooves towards either margin along each process.

Remarks: Elements of this subspecies developed uniformly-spaced denticles of varying height, resembling the prongs of a garden rake (MAWSON, 1986). *Oulodus greilingi hirpex* was found within the *eurekaensis, delta* and possibly *pesavis* Zone in New South Wales (Australia).

Oulodus spicula MAWSON, 1986

Pl. 10, Figs. 14, 15; Pl. 11, Fig. 1

Material: 22 specimens.

Sb element (Pl. 10, Figs. 14, 15)

1986 *Oulodus spicula* n. sp. MAWSON, p. 47; Pl. 3, Figs. 11–14.
1989 *Oulodus spicula* MAWSON – WILSON, p. 134; Pl. 7, Fig. 21.
1989 *Oulodus spicula* MAWSON – SORENTINO, p. 89; Pl. 6, Figs. 3, 5?
1999 *Oulodus spicula* MAWSON – TALENT & MAWSON, Pl. 6, Fig. 17.

Description: Both processes bear at least four or five equally, but rather widely spaced denticles. The cusp is subcircular in cross-section and slightly curved, pointing posteriorly. On either side of the cusp adjacent denticles are tiny and more spike-like compared to those following distally. They have a subcircular cross-section, measuring about one-third or less in diameter than other denticles on each process. Specimens illustrated have only the basal part of that spike-like denticles preserved, with the tip broken. The anterior lower margin is nearly straight, whereas the posterior lower margin is concave. Anterior and posterior lower margin include an angle between 80–105 degrees. The basal cavity is moderately deep with a rounded margin, extending only beneath the cusp. Basal grooves are moderately deep at the proximal part, becoming shallow and narrow distally.

Remarks: In MAWSON (1986), elements of *Oulodus spicula* are characterized by occurrence of two or three spike-like denticles close to the cusp. Some specimens possess randomly developed tiny denticles between normal-sized denticles. Observed elements lack intercalated tiny denticles on either distal extremity, bearing spike-like denticles proximal to the cusp only.

Pa element (Pl. 11, Fig. 1)

1980 *Delotaxis walliseri* (ZIEGLER) – PICKETT, p. 79; Fig. 10.K.
1986 *Oulodus spicula* n. sp. MAWSON, p. 47; Pl. 3, Figs. 1–4.
1995 *Oulodus* sp. COLQUHOUN, Pl. 2, Fig. 13.
2003 *Oulodus spicula* MAWSON – FARRELL, p. 126; Pl. 3, Fig. 1?

Remarks: The observed element is very similar to that of FARRELL (2003). The anterior process is fragmented covering three? (but usually up to five) denticles. The posterior process bears six denticles. The cusp and all proximal denticles are strongly broken, so that only the base of the typical spike-like denticles is observable on either side close to the cusp (at high magnification). Preserved distal denticles show a more V- than U-shaped spacing. The basal cavity surrounds a moderately deep basal pit. The margin of the basal cavity is rounded with the greatest width below the cusp. The lower margin remains inverted distally along the posterior process, but tapers rapidly below the anterior process, running as narrow basal groove distally.

Oulodus walliseri (ZIEGLER, 1960)

Pl. 10, Fig. 11?; Pl. 11, Figs. 10?, 11

General Remarks: Following the remarks of MAWSON (1986), elements of *Oulodus walliseri* strongly resemble those of *Oulodus aclys*. They differ in possessing peg-like denticles, rather than high, triangular ones with a broad base. The cusp is prominent, but not as high as the spear-like cusp of *Oulodus aclys*. *Oulodus walliseri* was found in the *woschmidti* Zone (ZIEGLER, 1960) and ranges up to the *sulcatus* Zone (FARRELL, 2003).

Material: 21 specimens.

Sa element (Pl. 10, Fig. 11?)

1986 *Oulodus walliseri* (ZIEGLER) – MAWSON, p. 48; Pl. 9, Fig. 4.
1994 *Oulodus* cf. *walliseri* (ZIEGLER) – MAWSON & TALENT, Fig. 14. C, G, I.
2006 *Oulodus* sp. cf. *Oul. walliseri* (ZIEGLER) – MATHIESON, p. 36; Pl. 6, Figs. G-I.

Description: One of either lateral processes and nearly the entire cusp is broken. The remaining process has seven discrete, almost equally sized, peg-like denticles. They are equally separated by narrow U-shaped gaps. The lower margin is gently arched, including an angle of a little less than 90 degrees. The basal cavity has a rounded margin and extends more wide than long towards the inner side. Basal grooves are inverted, tapering distally.

Remarks: The figured specimen could possibly be an Sb element. Compared to those illustrated in other papers it differs in possessing a strongly bent lower margin. Sa elements differ from the presented one in a stronger, more continuously curved lower margin of each process, and in less prominence of the inner margin of the basal cavity, forming a somewhat compressed lip-like outline.

M element (Pl. 11, Fig. 10?)

1986 *Oulodus walliseri* (ZIEGLER) – MAWSON, p. 48; Pl. 9, Fig. 5.
1994 *Oulodus* cf. *walliseri* (ZIEGLER) – MAWSON & TALENT, Fig. 14. D.
2003 *Oulodus* cf. *walliseri* (ZIEGLER) – FARRELL, p. 127; Pl. 3, Fig. 13.
2006 *Oulodus* sp. cf. *Oul. walliseri* (ZIEGLER) – MATHIESON, p. 36; Pl. 6, Fig. D?

Description: The remaining process is very low and untwisted. It bears ten erect, equally sized, peg-like denticles which are almost equally spaced. Spaces between denticles are narrowly U-shaped. The lower margin is gently arched. The basal groove is inverted.

Remarks: The figured element is regarded as the posterior process of an M element. A possible Sa position can be excluded, as these elements have a lower, more curved margin. Sb elements differ in possessing a slightly higher blade; the posterior process bears denticles pointing posteriorly. Sc elements have posterior-pointing denticles and usually not inverted, but open basal grooves. Pa and Pb elements possess inverted basal grooves becoming shallow and broader proximally to the basal cavity.

Pa element (Pl. 11, Fig. 11)

1980 *Delotaxis walliseri* (ZIEGLER) – PICKETT, p. 79; Figs. 10.A–10.F [cum syn.].
1994 *Oulodus* cf. *walliseri* (ZIEGLER) – MAWSON & TALENT, Fig. 14. A.
1995 *Oulodus* sp. cf. *O. walliseri* (ZIEGLER) – CAREY & BOLGER, p. 78; Fig. 4C.
1999 *Oulodus walliseri* (ZIEGLER) – TALENT & MAWSON, Pl. 6, Fig. 18.
2003 *Oulodus* cf. *walliseri* (ZIEGLER) – FARRELL, p. 127; Pl. 3, Figs. 10, 16.
2006 *Oulodus* sp. cf. *Oul. walliseri* (ZIEGLER) – MATHIESON, p. 36; Pl. 6, Figs. A, B.

Description: The figured element is strongly broken. The remaining process is twisted and relatively broad in upper view. It bears twelve narrow-spaced, discrete, peg-like, robust denticles. They are subequal in size with a nearly circular cross-section. A basal groove seems almost not present, forming a broad flat central part with an inverted outer margin running along either side.

Remarks: The obtained element closely resembles the Pa element of *Oulodus walliseri* in FARRELL, 2003 (Plate 3, Fig. 10).

Oulodus sp. A

Pl. 11, Fig. 6

Material: 1 specimen.

Sb element (Pl. 11, Fig. 6)

aff. 1989 *Oulodus* sp. A WILSON, p. 135; Pl. 8, Fig. 6.
aff. 2003 *Oulodus* spp. Group A FARRELL, p. 129; Pl. 4, Figs. 4, 7.
aff. 2004 *Oulodus* Group A FARRELL, p. 963; Pl. 5, Fig. 8.

Description: The very robust element has a prominent cusp, gently curving to the inner side distally. The anterior process bears five narrow-spaced denticles of subequal size. The posterior process is broken distally, bearing at least four discrete denticles. The cross-section of cusp and denticles is nearly circular. The lower margin of the descending processes is straight, meeting the horizontal margin below the cusp at an angle. The lower margin of the posterior process to the horizontal one below the cusp includes about 116 degrees, whereas that of the anterior process is wider including 132 degrees. The basal cavity extends rather widely with well rounded margins. Basal grooves are inverted.

Oulodus sp.

Pl. 10, Figs. 5?, 6, 9, 10; Pl. 11, Fig. 9

Material: 133 specimens.

Remarks: All elements, of which a proper assignment at species-level was impossible, are referred to *Oulodus* sp. only.

Order: Ozarkodinida DZIK, 1976
Family: Spathognathodontidae HASS, 1959
Genus: *Ancyrodelloides* BISCHOFF & SANNEMANN, 1958

Type species: *Ancyrodelloides trigonica* BISCHOFF & SANNEMANN, 1958.

Ancyrodelloides kutscheri BISCHOFF & SANNEMANN, 1958

Pl. 21, Figs. 1, 2

Material: 4 specimens.

Pa element (Pl. 21, Figs. 1, 2)

1958 *Ancyrodelloides kutscheri* n. sp. BISCHOFF & SANNEMANN, p. 93; Pl. 12, Figs. 15, 17, 18.
1968 *Ancyrodelloides* cf. *kutscheri* BISCHOFF & SANNEMANN – SCHULZE, p. 183; Fig. 11.
1969b *Ancyrodelloides kutscheri* BISCHOFF & SANNEMANN – PÖLSLER, p. 404; Pl. 1, Figs. 22, 23.
1978 *Ancyrodelloides kutscheri* BISCHOFF & SANNEMANN – SERPAGLI, GNOLI, MASTANDREA & OLIVIERI, Pl. 27, Fig. 3.
1979 *Ancyrodelloides kutscheri* BISCHOFF & SANNEMANN – LANE & ORMISTON, p. 52; Pl. 2, Figs. 14, 15, 18, 19.
1983 *Ancyrodelloides kutscheri* BISCHOFF & SANNEMANN – MURPHY & MATTI, p. 22; Pl. 3, Fig. 20.
1985a *Ancyrodelloides kutscheri* BISCHOFF & SANNEMANN – MASTANDREA, p. 244; Pl. 2, Fig. 4.
1986 *Ancyrodelloides kutscheri* BISCHOFF & SANNEMANN – BARCA, GNOLI, OLIVIERI & SERPAGLI, Pl. 31, Figs. 4, 7.
1991 *Ancyrodelloides kutscheri* BISCHOFF & SANNEMANN – KLAPPER, SWEET & ZIEGLER, p. 19; Pl. 1, Fig. 3.
1992 *Ancyrodelloides kutscheri* BISCHOFF & SANNEMANN – BARDASHEV & ZIEGLER, Pl. 2, Figs. 16, 18.
1998a *Ancyrodelloides kutscheri* BISCHOFF & SANNEMANN – CORRADINI, FERRETTI & SERPAGLI, Pl. 2.3.1, Fig. 7 [= specimen Pl. 2, Fig. 4; MASTANDREA, 1985a].

Description: A species of *Ancyrodelloides* with two lateral denticulate lobes, one of them being bifurcate. Both specimens figured are broken with the anterior process totally and the posterior process partially. Nevertheless a significant amount of the platform lobes remains. They join the main axis in the middle of the blade, with their proximal denticle in line with the cusp and each other. The angle between the anterior process and the anterior-pointing lobe is 35–45 degrees on either side. Also, the angle measured for the posterior-pointing lobe (of the bifurcate lobe) to the posterior-process falls within that range. In upper view the anterior pointing extremity of the branched lobe is more narrow and much shorter, bearing one to two denticles, whereas the remaining lateral lobes have 3–5 denticles each. Denticles are discrete, more or less equally spaced, conical, and of equal height. The face of the tips is finely striated, grading into a subtly reticulate (lower third of denticles to mid-height of platform) and finally smooth surface (mid-height of platform to lower margin). The blade, as far as preserved, seems unornamented. Usually denticles are straight, erect. Only one specimen (Plate 21, Fig. 1) has inclined denticles with their tips pointing towards the inner side in posterior view. The cusp is developed in the same style as the denticles and not elevated. The basal cavity is narrow, featuring a restricted pit. The basal groove is medium deep in central position, becoming adpressed towards the distal end of both lateral processes. Beneath the posterior process the groove is adpressed along its entire length. The cross-section of the main and lateral processes is bulging to subcircular in outline.

Remarks: MURPHY & MATTI (1983) proposed a close relation of *Ancyrodelloides kutscheri* to *Ancyrodelloides trigonicus*, because it differs only in bifurcation of one of the lateral lobes. Regarding the broken anterior process of all specimens obtained, no statement can be given; neither about its shape and platform development, nor about the basal groove's outline and extension. MURPHY & MATTI (1983) figured a sketch of *A. kutscheri* in lower view (their Text-Fig. 5.n.), showing that the basal groove of the anterior process, contrary to the posterior one, is open along two-thirds of its length until it becomes adpressed.

Ancyrodelloides limbacarinatus MURPHY & MATTI, 1983

Pl. 21, Figs. 4, 5

Material: 2 specimens.

Pa element (Pl. 21, Figs. 4, 5)

1980b *Ozarkodina limbacarinata* KLAPPER & MURPHY – SCHÖNLAUB, p. 39; Pl. 5, Fig. 3?, non Figs. 1, 2, 4, 5.
1983 *Ancyrodelloides limbacarinatus* n. sp. MURPHY & MATTI, p. 25; Pl. 4, Figs. 20–30, Text-Fig. 5.
1985a *Ozarkodina fluminensis* n. sp. MASTANDREA, p. 252; Pl. 2, Figs. 1, 3, 5, 6, 9, 10, 14, Text-Fig. 4.
1991 *Ancyrodelloides limbacarinatus* MURPHY & MATTI – KLAPPER, SWEET & ZIEGLER, p. 21; Pl. 2, Fig. 1 [= specimen Pl. 4, Figs. 20, 25, 26; MURPHY & MATTI, 1983].
1998a *Ancyrodelloides fluminensis* (MASTANDREA) – CORRADINI, FERRETTI & SERPAGLI, Pl. 2.3.1, Fig. 9 [= specimen Pl. 2, Fig. 9; MASTANDREA, 1985a].

Description: The platform reaches from almost the middle of the anterior blade to the posterior margin. The anterior part of the shouldered lobes is expanded twice as much as the proximal posterior part. The outer platform lobe is wider than the inner one and starts tapering posteriorly at a more distal point. The outer margin of the outer lobe is bent upward forming a parapet. The smaller inner lobe is rather flat, except for the second specimen, where a less prominent raised outer margin is developed, surrounding a nearly flat but depressed upper surface. A granulose texture on both platform lobes is discernible, but the ornament is restricted to the upper platform surface, with the lateral margin and lower face remaining smooth. The basal pit is rather deep and located below to somewhat anterior to the cusp. It continues to a shallow basal cavity beneath the distally rounded lobes. The cavity is distinctively restricted to the area below the anterior expanded part of the platform lobes. The basal groove is inverted. The lower margin is straight anteriorly and concave posteriorly in lateral view. Denticles show an elliptical cross-section. Anterior denticles are high, followed by smaller denticles which are lower in lateral view. Cusp and posterior denticles are of moderate height and rather triangular with a broad base. Denticles of both specimens show a fine striated surface.

Remarks: *Ancyrodelloides limbacarinatus* has been referred together with *A. delta* to the genus *Kimognathus* by MURPHY & VALENZUELA-RÍOS, 1999 (mentioned as a short note on page 323). This decision is not followed, due to the fact that detailed data regarding the stated progenitor development were not published. Obtained specimens can be distinguished easily from *A. delta* by the outline of the basal cavity and the parapet-like outer margin of the outer lobe (the latter is unique for *A. limbacarinatus*).

Ancyrodelloides transitans (BISCHOFF & SANNEMANN, 1958) alpha morph LANE & ORMISTON, 1979

Pl. 21, Figs. 3, 6, 7

Material: 7 specimens.

Pa element (Pl. 21, Figs. 3, 6, 7)

1979 *Ozarkodina transitans* (BISCHOFF & SANNEMANN) alpha morph – LANE & ORMISTON, p. 58; Pl. 3, Fig. 21, Text-Fig. 7.
1980b *Ozarkodina transitans* (BISCHOFF & SANNEMANN) – SCHÖNLAUB, p. 39; Pl. 5, Figs. 8, 10–13 and p. 42; Pl. 7, Fig. 4.
1985 *Ancyrodelloides transitans* (BISCHOFF & SANNEMANN) – CHLUPÁČ, LUKEŠ, PARIS & SCHÖNLAUB, p. 26; Pl. 2, Fig. 28.
1985a *Ozarkodina transitans* (BISCHOFF & SANNEMANN) alpha morph – MASTANDREA, p. 255; Pl. 5, Fig. 14.
1985b *Ancyrodelloides transitans* (BISCHOFF & SANNEMANN) – SCHÖNLAUB, Pl. 3, Fig. 1.
1992 *Cruciodus transitans* (BISCHOFF & SANNEMANN) – BARDASHEV & ZIEGLER, p. 14; Pl. 2, Figs. 14?, 15?, 19?
1994a *Ancyrodelloides transitans* (BISCHOFF & SANNEMANN) – VALENZUELA-RÍOS, p. 41; lam. 1, Figs. 11, 14–18.
1998 *Ancyrodelloides transitans* (BISCHOFF & SANNEMANN) – SLAVÍK, p. 159; Pl. 1, Fig. 3.
1998 *Ancyrodelloides transitans* (BISCHOFF & SANNEMANN) – VALENZUELA-RÍOS & GARZÍA LÓPEZ, Pl. 1 Figs. 6, 8, 9?
2003 *Ancyrodelloides transitans* (BISCHOFF & SANNEMANN) alpha morphotype LANE & ORMISTON – FARRELL, p. 132; Pl. 5, Figs. 10–12.

Description: The axis of the blade is slightly arched but can be straight in some specimens. The lower margin usually is straight in lateral view. A few specimens possess an anterior margin which is a little raised, resulting in a slightly convex lower margin of the anterior process. The posterior process is inflated, oval in cross-section. The basal cavity is deeper below the cusp and runs – strongly narrowed – to the anterior and posterior margin of the main process (as far as preserved). Below the lateral lobes, the cavity is somewhat club-shaped and laterally bluntly rounded. Each lateral process bears one discrete accessory denticle located in the middle to distal position of the lobe. Denticles of lateral lobes are aligned with the cusp. The anteriormost two or three denticles, and in some specimens the cusp too, are raised and a little wider at the base than other denticles of the blade. Denticles are discrete, closely spaced and sometimes fused at the base. The cross-section ranges from subcircular to oval, whereas centred denticles tend to be more circular. The tip can be acute to bluntly rounded. Denticles of some specimens have a fine striation which may cover part of the platform. The free blade remains unornamented.

Remarks: The most important criteria for distinguishing *Ancyrodelloides transitans* and *A. trigonicus* are the shape of the basal cavity and the cross-section of the platform of the posterior process, which, in the case of *A. trigonicus*, is of bench-like shape. The latter characteristic feature can also be developed in *A. transitans*, but never that wide. The basal cavity in *A. trigonicus* can be restricted (adult specimen) or possess pointed distal ends on each lateral process (juvenile specimen). By contrast, *A. transitans* has a club-shaped (juvenile specimen) to narrow, but open basal cavity (adult specimen) on either lateral process. MURPHY & MATTI (1983) suggested that the angle including the lateral and anterior processes might be a less distinctive feature, as it has a wide range of variation producing several kinds of intermediate stages between both species.

Ancyrodelloides transitans (BISCHOFF & SANNEMANN, 1958) beta morph LANE & ORMISTON, 1979

Pl. 21, Fig. 8

Material: 3 specimens.

Pa element (Pl. 21, Fig. 8)

1958 *Spathognathodus transitans* n. sp. BISCHOFF & SANNEMANN, p. 107; Pl. 13, Figs. 4, 12, 14?
1979 *Ozarkodina transitans* (BISCHOFF & SANNEMANN) beta morph – LANE & ORMISTON, p. 58; Pl. 2, Figs. 4, 5, Text-Fig. 7.
1986 *Ancyrodelloides transitans* (BISCHOFF & SANNEMANN) – BARCA, GNOLI, OLIVIERI & SERPAGLI, Pl. 31, Fig. 6.
1989 *Ancyrodelloides transitans* (BISCHOFF & SANNEMANN) beta morph LANE & ORMISTON – WILSON, p. 137; Pl. 12, Figs. 18, 19.
1994a *Ancyrodelloides transitans* (BISCHOFF & SANNEMANN) – VALENZUELA-RÍOS, p. 41; lam. 2, Figs. 2, 4.
1998 *Ancyrodelloides transitans* (BISCHOFF & SANNEMANN) beta morph LANE & ORMISTON – ÇAPKINOĞLU & BEKTAŞ, p. 163; Pl. 1, Figs. 1, 2.
1998 *Ancyrodelloides transitans* (BISCHOFF & SANNEMANN) – SLAVÍK, p. 159; Pl. 1, Fig. 4.
1998 *Ancyrodelloides transitans* (BISCHOFF & SANNEMANN) – VALENZUELA-RÍOS & GARZÍA LÓPEZ, Pl. 1, Fig. 10.

Description: Features are similar to those asserted for the alpha morph except for the number of denticles on lateral processes. Whereas the alpha morph bears one denticle on either lateral lobe, the beta morph developed a second accessory denticle on the inner lobe. That denticle is half the height of the proximal one and occupies a position close to the distal margin of the lobe. The outline of the basal cavity and the cross-section of the posterior process is like that of the alpha morph.

Remarks: LANE & ORMISTON (1979) pointed out, that the beta morph may have persisted into the *pesavis* Zone. In MURPHY & MATTI (1983), the *transitans* group ranges from the lower *delta* Zone into the lowermost *pesavis* Zone. All other species included in the genus *Ancyrodelloides* disappear at different levels within the upper *delta* Zone.

Ancyrodelloides transitans (BISCHOFF & SANNEMANN, 1958) intermediate form MASTANDREA, 1985a

Pl. 21, Fig. 9

Material: 2 specimens.

Pa element (Pl. 21, Fig. 9)

1968 *Spathoganthodus transitans* BISCHOFF & SANNEMANN – SCHULZE, p. 230; Pl. 16, Fig. 2.
1969 *Ancyrodelloides trigonica* BISCHOFF & SANNEMANN – CARLS, p. 325; Pl. 1, Fig. 1.
1980a *Ancyrodelloides* sp. aff. *A. trigonica* BISCHOFF & SANNEMANN – SCHÖNLAUB, FLAJS & THALMANN, Pl. 1, Figs. 3, 4.
1983 *Ancyrodelloides transitans* (BISCHOFF & SANNEMANN) – MURPHY & MATTI, p. 22; Pl. 2, Figs. 9–11.
1985a *Ozarkodina transitans* (BISCHOFF & SANNEMANN) intermediate form – MASTANDREA, p. 255; Pl. 5, Figs. 18, 19.
1985a *Ancyrodelloides trigonicus* BISCHOFF & SANNEMANN – MASTANDREA, p. 244; Pl. 2, Figs. 7, 8, non Figs. 11–13, 15.
1991 *Ancyrodelloides transitans* (BISCHOFF & SANNEMANN) – KLAPPER, SWEET & ZIEGLER, p. 25; Pl. 1, Fig. 4 [= specimen Pl. 2, Figs. 10, 11; MURPHY & MATTI, 1983].
1998a *Ancyrodelloides trigonicus* BISCHOFF & SANNEMANN – CORRADINI, FERRETTI & SERPAGLI, Pl. 2.3.1, Fig. 8 [= specimen Pl. 2, Fig. 8; MASTANDREA, 1985a].

Description: Each platform lobe forms an angle of 80 degrees with the anterior process. Both lateral extremities are shaped almost symmetrically, are of equal length, and have two denticles on either side, whereas the proximal denticle is of normal height and the distal one rather small and node-like. The anterior free blade bears one small initially and two raised denticles with the following ones almost uniform in shape, decreasing in height within the posteriormost fifth. Denticles and the upper and lateral platform surface show a reticulate ornament. The lower platform area and the blade are smooth. The cross-section of the posterior process is oval and of rather broad width. The lower margin is slightly arched. The axis is gently curved (nearly S-shaped) in upper view, with the posterior margin pointing towards the outer side. The basal cavity is narrow, with basal grooves extending to either margin. The outline of the cavity below each lateral process is somewhat club-shaped, with rounded distal ends.

Remarks: The figured specimen seems to be an intermediate morphotype between *Ancyrodelloides transitans* and *Ancyrodelloides trigonicus*. The outline of the lateral face is very similar to that in SCHÖNLAUB et al. (1980a, Pl. 5, Fig. 13), except that the lateral lobes are of unequal length (Plate 5, Fig. 12, therein). Nonetheless the outline of the basal cavity is closer to that of *A. transitans*. It is not as restricted as is typical for *A. trigonicus* and the transition form *A. transitans* delta morph proposed by LANE & ORMISTON (1979, Pl. 1, Fig. 41; Pl. 2, Figs. 12, 13). The specimen presented by CARLS (1969) has a similar shaped cavity and platform denticulation, although the distal denticle on both lateral processes seems to be bigger in his specimen. Another difference is the grade of curvature of the lateral processes pointing anteriorly. The specimens herein have a more gentle bent transverse axis of the lateral lobes, unlike that of *A. trigonicus* but, in contrast to the specimen figured in MURPHY & MATTI (1983), both lateral lobes include an angle less than 90 degrees. Although several features resemble *A. trigonicus*, the most discriminative one (the outline of the basal cavity) corresponds to that of *A. transitans*. Therefore I regard both obtained Pa elements as intermediate morphotype, with closer relations to *Ancyrodelloides transitans*.

Genus: *Flajsella* VALENZUELA-RÍOS & MURPHY, 1997

Type species: *Spathognathodus stygius* FLAJS, 1967.

Flajsella schulzei (BARDASHEV, 1989)

Pl. 18, Fig. 11

Material: 9 specimens.

Pa element (Pl. 18, Fig. 11)

1968 *Spathognathodus seebergensis* n. sp. SCHULZE, p. 227; Pl. 17, Fig. 9?
1969b *Spathognathodus stygius* FLAJS – PÖLSLER, p. 433; Pl. 1, Figs. 5, 6.
1980b *Ozarkodina stygia* (FLAJS) alpha morph – SCHÖNLAUB, p. 39; Pl. 4, Figs. 5–8.
1985a *Ozarkodina stygia* (FLAJS) beta morph – MASTANDREA, p. 255; Pl. 3, Fig. 2?
1992 *Ozarkodina stygia schulzei* BARDASHEV – BARDASHEV & ZIEGLER, p. 15; Pl. 1, Fig. 39, non Figs. 25, 26.
1994a *Ozarkodina stygia* (FLAJS) – VALENZUELA-RÍOS, p. 66; lam. 6, Figs. 16, 21.
1997 *Flajsella schulzei* (BARDASHEV) – VALENZUELA-RÍOS & MURPHY, p. 136; Fig. 8: 1–4, 7–22.
1998 *Flajsella schulzei* (BARDASHEV) – VALENZUELA-RÍOS & GARZÍA LÓPEZ, Pl. 1, Figs. 1, 2.
1999 *Flajsella schulzei* (BARDASHEV) – TALENT & MAWSON, p. 74; Pl. 11, Fig. 19.

Description: The basal platform is spear-like in shape (margin partly broken). It extends from the middle of the blade to the posterior margin. The blade is gently twisted, but continues almost in line with a slightly deflected posterior carina in upper view. It bears 9 denticles anterior and 4 posterior of the cusp. Whereas the denticles of the high anterior blade are more palisade- than needle shaped, those of the posterior blade are conspicuously small and seem to be discrete. The posterior blade is about one-third of the height of the anterior blade. The inflated conical cusp has a position in the posterior third and is almost equal in height to the denticles of the anterior blade. In cross-section the denticles and the cusp are elliptical to almost lenticular. The lower margin is arched, pointing downward at both ends with the highest point anterior of the cusp. The lateral face of the blade is partly covered with fine striae parallel to the anterior margin. The tips of the denticles and the cusp as well as the lower third of the lateral face remain smooth.

Remarks: In the frame of the revised diagnosis and discussion of this species, VALENZUELA-RÍOS & MURPHY (1997) mentioned that the straight anterior and the posterior carina are aligned in upper view, without offset or angle at the cusp. This feature is not clearly discernible for the specimen figured, as the blade is gently twisted in upper view (postdiagenetic processes?). Several other features correspond to the original description. In the Seewarte section Pa elements are found in the middle part of the *delta* Zone.

Flajsella stygia (FLAJS, 1967)

Pl. 18, Figs. 12, 13

Material: 37 specimens.

Pa element (Pl. 18, Figs. 12, 13)

1967 *Spathognathodus stygius* FLAJS, p. 204; Pl. 5, Figs. 12?, 13?, 14?, 15?, 16, 17, Text-Fig. 7.
1968 *Spathognathodus seebergensis* n. sp. SCHULZE, p. 227; Pl. 17, Fig. 4, 10?, 11?
1969b *Spathognathodus stygius* FLAJS – PÖLSLER, p. 433; Pl. 1, Figs. 1–4.
1979 *Ozarkodina stygia* (FLAJS) beta morph – LANE & ORMISTON, p. 57; Pl. 1, Figs. 45, 46.
1979 *Ozarkodina stygia* (FLAJS) gamma morph – LANE & ORMISTON, p. 57; Pl. 2, Figs. 10, 11.
1980b *Ozarkodina stygia* (FLAJS) gamma morph – SCHÖNLAUB, p. 39; Pl. 4, Figs. 23, 24?, 25, non Figs. 21, 22.
1980b *Ozarkodina stygia* (FLAJS) – SCHÖNLAUB, p. 28; Pl. 2, Figs. 12?, 25, 26, non Figs. 13, 14, 18, 19.
1985a *Ozarkodina stygia* (FLAJS) beta morph – MASTANDREA, p. 255; Pl. 3, Fig. 1.
1985b *Ozarkodina stygia* (FLAJS) – SCHÖNLAUB, Pl. 2, Figs. 12?, 25, 26.
1992 *Ozarkodina stygia sorokini* BARDASHEV – BARDASHEV & ZIEGLER, p. 15; Pl. 1, Figs. 22, 23, 31, 32, 36?, 37?
1992 *Ozarkodina stygia stygia* BARDASHEV – BARDASHEV & ZIEGLER, p. 15; Pl. 1, Figs. 34, 35?, 38?
1994a *Ozarkodina stygia* (FLAJS) – VALENZUELA-RÍOS, p. 66; lam. 6, Figs. 17–19.
1997 *Flajsella stygia* (FLAJS) – VALENZUELA-RÍOS & MURPHY, p. 139; Fig. 8: 26–28; Fig. 9: 26–30.
1998 *Flajsella stygia* (FLAJS) – VALENZUELA-RÍOS & GARZÍA LÓPEZ, Pl. 1, Fig. 4.

Description: The axis of the blade ranges from a little to strongly sigmoidal, resulting in an angle or offset where both processes join the cusp. The anterior blade (broken in both figured specimens) remains straight until near the cusp where the axis is strongly bent before joining the cusp. The rudimentary posterior blade is nearly straight and joins the cusp including an angle of about 10 degrees to a projected straight main axis. 6 to 7 denticles are present on the anterior blade and only one (rather node-like) on the posterior blade. The cusp is almost as high as denticles of the anterior process with an acute tip pointing posteriorly. A broad U-shaped space is observed between the cusp and the first denticle of the posterior blade in both figured specimens. Cusp and denticles have an elliptical cross-section. The platform has an asymmetrical outline with the outer lobe wider. It covers between one-half to two-thirds of the main axis length and reaches the posterior margin. The lower margin is almost straight. A fine striation is visible on the lateral face of the anterior blade of some specimens. Others remain totally unornamented.

Remarks: This species differs from *Flajsella schulzei* in possessing an angle or offset where the anterior and posterior carina meet the cusp and in the development of asymmetric platform lobes. Some Pa elements show a slightly curved anterior blade in upper view, which corresponds to one of the features of *Flajsella streptostygia*. Nevertheless they are assigned to *F. stygia*, as the denticles of the anterior blade remain highest in the anterior third and the platform extends more than one-third of the main axis length.

Flajsella sp.

Pl. 15, Figs. 11, 12

Material: 20 specimens.

Pa element

Remarks: Specimens possessing features of *Flajsella stygia* and *F. streptostygia*, and those too broken for specific determination are included here.

Pb element (Pl. 15, Figs. 11, 12)

aff. 1979 *Ozarkodina stygia* (FLAJS) gamma morph – LANE & ORMISTON, p. 57; Pl. 2, Fig. 25.
aff. 1985a *Ozarkodina stygia* (FLAJS) – MASTANDREA, p. 255; Pl. 3, Fig. 10.
aff. 1997 *Flajsella streptostygia* VALENZUELA-RÍOS & MURPHY, p. 140; Fig. 9: ?20.

Description: The processes of both Pb elements figured, are almost of equal length with a straight axis. The anterior process bears 6 and the posterior 4–5 denticles. The cusp is slightly reclined with its tip pointing posteriorly. It is one-third to twice as high as the proximal posterior blade. Anterior denticles are fused with needle-shaped free tips increasing in height towards the posterior. Tips are aligned with the anterior margin of the cusp in lateral view. Those of the posterior process (partly broken) decrease in height to the posterior margin. The lower margin is nearly straight, but some specimens have a gently inclined posterior lower margin and a slightly down-curving anterior lower margin. The anterior margin is strongly curved with the anteriormost denticle arcuate. The basal cavity is deep below the cusp with a nearly lens-shaped outline covering one-third of the entire axis length, located centrally in lower view. The anterior basal groove remains narrow but open until the middle of the anterior blade, continuing closed to the anterior margin. The posterior basal groove is broken, but seems to continue narrowly opened to the posterior margin.

Remarks: Some of the obtained Pb elements are similar to that figured in VALENZUELA-RÍOS & MURPHY, 1997 (Fig. 9: 20), but the authors pointed out that it is one of four candidates proposed for the apparatus of *F. streptostygia*. Apparatus reconstruction for this genus is still not sufficienty developed that unequivocal assignment of Pb elements can be made at species-level.

Genus: *Lanea* MURPHY & VALENZUELA-RÍOS, 1999

Type species: *Ozarkodina eleanorae* LANE & ORMISTON, 1979.

Lanea omoalpha MURPHY & VALENZUELA-RÍOS, 1999

Pl. 19, Figs. 5, 8, 10

Material: 4 specimens.

Pa element (Pl. 19, Figs. 5, 8, 10)

1958 *Spathognathodus fundamentatus* WALLISER – BISCHOFF & SANNEMANN, p. 105; Pl. 14, Figs. 1–3.
1969 *Spathognathodus steinhornensis* n. ssp. A. CARLS, p. 341; Pl. 3, Figs. 7, 8.
1983 *Ancyrodelloides omus* alpha morph MURPHY & MATTI, p. 16; Pl. 2, Figs. 18–20.
1994 *Ancyrodelloides omus* alpha morph MURPHY & MATTI – MAWSON & TALENT, p. 51; Fig. 11 (H–L).
1994a *Ancyrodelloides omus* morfotipo δ, nuevo morfotipo VALENZUELA-RÍOS, p. 40; lam. 1, Fig. 10.
1999 *Ancyrodelloides omus* MURPHY & MATTI – TALENT & MAWSON, p. 73; Pl. 5, Figs. 6–9; Pl. 7, Fig. 13; Pl. 8, Figs. 4, 11.
1999 *Lanea omoalpha* n. sp. MURPHY & VALENZUELA-RÍOS, p. 327; Pl. 1, Figs. 10–19, 23, 27–29; Pl. 2, Figs. 12–14.
2004 *Lanea omoalpha* – FARRELL, p. 976; Pl. 8, Figs. 12, 13.
2004 *Lanea* aff. *omoalpha* MURPHY & VALENZUELA-RÍOS – SLAVÍK & HLADIL, p. 147; Pl. 1, Fig. 10.
2005 *Lanea omoalpha* MURPHY & VALENZUELA-RÍOS – VALENZUELA-RÍOS, LIAO, MARTÍNEZ-PÉREZ, CASTELLÓ & BOTELLA, lam. 1, Figs. e, f.
2006 *Ancyrodelloides omus* MURPHY & MATTI – MATHIESON, p. 42; Pl. 13, Figs. A-F.

Description: Elements are characterised by terraced platform lobes. The platform is positioned nearly centrally to slightly posteriorly. Lobes are asymmetrical with a rounded to subsquare outline in upper view. The anterior transverse margin of the terrace is in line with the front of the cusp in upper view. The area of the terrace covers about one-half of the surface area of the platform lobe, meeting the brim at a slightly obtuse angle. The ratio of brim to terrace, measured from proximal anterior to posterior platform margin, is 1:2:1 for the figured specimens. The lateral face of the blade shows a weak to moderate pinch zone that is limited to the lower one-third of the blade. Its upper horizontal margin is almost in line with the upper surface of the terrace extenting to the lower margin. The main axis is nearly straight. Denticles possess a stout to palisade-like outline with a lens-shaped cross-section. One of the anterior denticles is very high and broad at its base. Other specimens obtained have two or three enlarged anterior denticles. Denticles of the posterior process are moderately high with two or three of them larger in size. The cusp is prominent but not higher than denticles of the posterior blade, with smaller denticles of irregular height on either side characterising the denticles of the mid-blade area. The lower margin is stepped with anterior and posterior lower margins straight to slightly arched. The basal cavity is deep and not restricted. Basal grooves are medium to rather deep and continue open to the anterior and posterior margins where both taper to a point. Pa elements are smooth, but may show granulose texture restricted to the surface of the terrace (compare Plate 19, Fig. 10b).

Remarks: Distinguishing features for this species compared to other ones included in *Lanea* are the unconstricted basal cavity and the size of the brim in relation to the area of the terrace. Additionally MURPHY & VALENZUELA-RÍOS (1999) mentioned that the profile of the upper margin is concave and those of the lower margin slightly convex, which is not clearly observable for some specimens obtained.

Lanea eoeleanorae MURPHY & VALENZUELA-RÍOS, 1999

Pl. 19, Fig. 14

Material: 5 specimens.

Pa element (Pl. 19, Fig. 14)

1980 *Ozarkodina* cf. *asymmetrica* BISCHOFF & SANNEMANN – SCHÖNLAUB, Pl. 4, Figs. 3, 4.
1992 *Cruciodus eleanorae* (LANE & ORMISTON) – BARDASHEV & ZIEGLER, p. 14; Pl. 2, Figs. 4, 5, 10.
1999 *Lanea eoeleanorae* n. sp. MURPHY & VALENZUELA-RÍOS, p. 327; Pl. 1, Figs. 20–22, 24–26, 30; Pl. 2, Figs. 1–11, 21–23.
2005 *Lanea eoeleanorae* MURPHY & VALENZUELA-RÍOS – VALENZUELA-RÍOS, LIAO, MARTÍNEZ-PÉREZ, CASTELLÓ & BOTELLA, lam. 1, Figs. c, d.

Description: The broken Pa element displays a posterior blade with descending upper profile and a lower margin slightly bent downward. Denticles are discernible only by the undulating lateral face and free blunt tips. Cusp and denticles are of rather equal shape, with the tip of the cusp having little wider spaces on either side of the carina. The main axis is straight to slightly arched. Unequal, distally rounded platform lobes are shouldered, with a terrace covering nearly the entire platform area, so that no discrete brim is perceivable in upper view. The anterior and posterior margin of each platform-lobe terrace joins the surface of the brim almost perpendicularly. A shallow brim sulcus is visible in lateral view. The pinch zone of the posterior lower blade is well developed to highly adpressed close to the lower margin. The basal cavity is open, possessing a moderate deep basal pit shallowing below the platform lobes. Though strongly pinched, the posterior groove remains shallow but open, tapering to a point posterior. No surface texture is apparent.

Remarks: The obtained element differs in possessing stout, but bluntly rounded denticle tips, with the major part of the denticles nearly indiscernible, fused with only an undulated lateral face remaining. The anterior blade, though nearly completely absent, exhibits a proximal cross-section which has an adpressed rather than deep and open basal groove. Only one of the platform lobes developed a weak brim sulcus on the rounded distal margin in anterior view. All these features differ from the description of MURPHY & VALENZUELA-RÍOS (1999).
The presence of a brim sulcus and the almost equal size of terrace and platform area distinguishes *Lanea eoeleanorae* from *L. omoalpha*. In contrast to *L. eleanorae*, the basal cavity is open with no bench developed along the blade.

Lanea telleri (SCHULZE, 1968)

Pl. 19, Figs. 11, 12

Material: 8 specimens.

Pa element (Pl. 19, Figs. 11, 12)

1968 *Spathognathodus steinhornensis telleri* n. subsp. SCHULZE, p. 229; Pl. 17, Figs. 18, 19.
1978 *Spathognathodus steinhornensis telleri* SCHULZE – SERPAGLI, GNOLI, MASTANDREA & OLIVIERI, Pl. 27, Figs. 2, 6.
1980 *Ozarkodina eleanorae* LANE & ORMISTON – KLAPPER & MURPHY, Figs. 4.1, 4.7–4.9, 4.13, 4.14.
1980b *Pandorinellina steinhornensis telleri* (SCHULZE) – SCHÖNLAUB, Pl. 2, Fig. 20/52b.
1983 *Ancyrodelloides eleanorae* (LANE & ORMISTON) – MURPHY & MATTI, Pl. 4, Figs. 4–6.
1985a *Ozarkodina steinhornensis telleri* (SCHULZE) – MASTANDREA, p. 254; Pl. 4, Figs. 2–6.
1987 *Ancyrodelloides eleanorae* (LANE & ORMISTON) – MURPHY & CEBECIOĞLU, Tab. 2, Figs. 1, 5, 6.
1991 *Ancyrodelloides eleanorae* (LANE & ORMISTON) – KLAPPER, SWEET & ZIEGLER, p. 17; Pl. 2, Fig. 3.
1994a *Ancyrodelloides eleanorae* (LANE & ORMISTON) – VALENZUELA-RÍOS, p. 50; lam. 4, Figs. 10–12, 14–16.
1998a *Pandorinellina steinhornensis telleri* (SCHULZE) – CORRADINI, FERRETTI & SERPAGLI, Pl. 2.3.1, Fig. 6 [= specimen Pl. 4, Fig. 3; MASTANDREA, 1985a].
1999 *Lanea telleri* (SCHULZE) – MURPHY & VALENZUELA-RÍOS, p. 330; Pl. 2, Figs. 24–38.

Description: The axis of the blade is gently arched. The lower margin of both processes is slightly bent downward, with the highest point below the platform lobes. The basal platform is located posterior to the centre of the blade resulting in a shorter posterior process measuring about two-thirds the length of the anterior one. Denticles have a pallisade-like shape. They are raised anteriorly, descending towards the cusp. The anterior blade bears 10 denticles and the posterior one 4, with two of them enlarged. Mid-blade denticles are almost uniform, except those next to the cusp, which are smaller and less broad. The basal platform is terraced with less prominent anterior and bulging posterior benches along the blade. The cross-section of the broken platform lobe shows a narrow marginal ridge ("rim") framing the platform in upper view; it is a typical feature of this species. The basal cavity is restricted in its extension. It has a deep basal pit and adpressed anterior and posterior basal grooves. The surface of the blade and the platform is smooth, whereas denticles show fine striated texture.

Remarks: MURPHY & VALENZUELA-RÍOS (1999) pointed out that juvenile Pa elements may lack the distinct rim in very early ontogenetic stages of the species. One of the specimens obtained (Plate 19, Fig. 12) is regarded as representing such a Pa element of a juvenile *Lanea telleri*. The element is similar to that figured in MASTANDREA (1985a; Plate 4, Fig. 5), with the exception that both platform lobes (although possessing slightly broken platform margins) join the blade in a right rather than acute angle. A shallow furrow-like depression of the anterior half of one of the lobes (extending parallel to anterior platform margin) is visible in upper view. In the Seewarte section *Lanea telleri* ranges from the middle to upper *delta* Zone.

Genus: *Ozarkodina* BRANSON & MEHL, 1933

Type species: *Ozarkodina typica* BRANSON & MEHL, 1933.

Ozarkodina camelfordensis FARRELL, 2004

Pl. 18, Fig. 5

Material: 1 specimen.

Pa element (Pl. 18, Fig. 5)

2003 *Ozarkodina* cf. *canadensis* (WALLISER) – FARRELL, p. 135; Pl. 7, Figs. 3–10.

2004 *Ozarkodina camelfordensis* sp. nov. FARRELL, p. 966; Pl. 7, Figs. 1–14.

Description: The obtained element has a nearly straight axis with only the anteriormost part gently curved. The anterior process bears 6 denticles of uneven size with the second one largest. The posterior process covers 5 denticles of different size, the third and fourth (counted from the cusp distally) being enlarged. All are triangular in lateral view. The cusp is prominent too and almost as high as the second anterior denticle. The anterior lower margin is rather straight to slightly inclined, whereas the posterior one is weakly stepped. The basal platform is slightly asymmetrical, with a subequally rounded to tongue-like outline. The basal cavity occupies a nearly central position. Platform lobes gently taper distally, almost reaching the posterior margin before meeting the blade. Along the anterior process, the tapering margin of the lobes joins the blade at mid-length. The posterior basal groove remains open towards the posterior margin, whereas the anterior basal groove becomes closed below the anterior high denticles. The horizontal lower third of the blade is pinched proximally to either side of the platform lobes.

Remarks: Pa elements of *Ozarkodina camelfordensis* are very similar in shape to *Ozarkodina canadensis*. Both possess an asymmetrical, tongue-like basal platform and enlarged denticles (anteriormost and above the basal cavity). The diagnostic feature separating the species from each other is the development of 1 or 2 prominent denticles within the mid-region of the posterior process of *Ozarkodina camelfordensis*. The specimen found in the Seewarte section was obtained from Lower Lochkovian strata of the Rauchkofel Formation.

Ozarkodina excavata excavata (BRANSON & MEHL, 1933)

Pl. 1, Fig. 3; Pl. 12, Figs. 1, 7; Pl. 13, Figs. 3, 5, 8, 9; Pl. 14, Figs. 2–11; Pl. 16, Figs. 1–7, 9; Pl. 17, Figs. 1–3, 5

General Remarks: MURPHY et al. (2004) elevated some of the most common conodont species around the Silurian-Devonian boundary to the level of newly introduced genus (e.g.: *Ozarkodina excavata* ssp. = *Wurmiella* sp.; *Ozarkodina r. remscheidensis* = *Zieglerodina remscheidensis*; *Ozarkodina r. eosteinhornensis* = *W. eosteinhornensis*). This proposition is not adopted herein. In their paper, they figured complete reconstructed apparatuses of *'Wurmiella excavata'* and *'Wurmiella tuma'* but no elements of *'Wurmiella wurmi'*. Detailed descriptions of the proposed apparatuses of the latter two species are given in the text, except *'Wurmiella excavata'* of which the Pa element (as most discriminative element distinguishing the species) is mentioned only in comparison with *'Wurmiella tuma'* and *'Wurmiella wurmi'* (page 11, therein).

Elements of the transition series that show great affinity to those in MURPHY et al. (2004, Figs. 2.23–2.28) are assigned to *Ozarkodina* cf. *O. excavata tuma* MURPHY & MATTI, 1983. The possibility, that the latter specimens are variations of *Ozarkodina excavata excavata* has to be taken into account, as MURPHY et al., 2004 (page 12) pointed out, that *'W. tuma'* represents a short-ranging species (middle Lochkovian) of local distribution in central Nevada. Platform elements of *O. excavata excavata* and *O. excavata tuma* can be discriminated easily by considering the ratio of denticle numbers to the entire length of the blade (MURPHY & CEBECIOĞLU, 1986). *Ozarkodina excavata tuma* is characterised by possessing a higher number of denticles per mm compared to *O. excavata excavata*.

Illustrated Pa elements assigned to *O. excavata excavata* differ from those figured in BARDASHEV & ZIEGLER (1992) by having exclusively a straight or stepped outline of the blade's lower margin. Following MURPHY et al. (2004) a convexo-concave or biconcave basal margin is one of the diagnostic features of *'Wurmiella wurmi'* within the revised diagnosis (page 12, therein).

Material: 1865 specimens.

Sa element (Pl. 12, Fig. 7)

1933 *Trichognathus excavata* n. sp. BRANSON & MEHL, p. 51; Pl. 3, Figs. 35, 36.

1962 *Trichonodella excavata* (BRANSON & MEHL) – ETHINGTON & FURNISH, p. 1287; Pl. 173, Fig. 8.

1964 *Trichonodella excavata* (BRANSON & MEHL) – WALLISER, p. 89; Pl. 8, Fig. 2; Pl. 31, Figs. 26, 27.

1966 *Trichonodella excavata* (BRANSON & MEHL) – PHILIP, p. 451; Pl. 3, Fig. 22; Pl. 4, Figs. 22, 29.

1971 *Trichonodella excavata* (BRANSON & MEHL) – BULTYNCK, p. 35; Pl. 2, Fig. 9?

1971 *Trichonodella excavata* (BRANSON & MEHL) – REXROAD & CRAIG, p. 701; Pl. 79, Figs. 43?, 44–46.

1975 *Ozarkodina excavata excavata* (BRANSON & MEHL) – KLAPPER & MURPHY, p. 34; Pl. 6, Figs. 5, 6.

1975 *Trichonodella excavata* (BRANSON & MEHL) – TELFORD, p. 75; Pl. 16, Figs. 1–3.

1979 *Ozarkodina excavata excavata* (BRANSON & MEHL) – LANE & ORMISTON, p. 55; Pl. 9, Fig. 22.

1985a *Ozarkodina excavata excavata* (BRANSON & MEHL) – MASTANDREA, p. 250; Pl. 1, Fig. 14?

1986 *Ozarkodina excavata excavata* (BRANSON & MEHL) – MAWSON, p. 48; Pl. 4, Figs. 10–16.
1986 *Ozarkodina excavata* (BRANSON & MEHL) – MURPHY & CEBECIOĞLU, Fig. 1.11.
1989 *Ozarkodina excavata excavata* (BRANSON & MEHL) – SORENTINO, p. 92; Pl. 1, Figs. 13–15.
1989 *Ozarkodina excavata excavata* (BRANSON & MEHL) – WILSON, p. 137; Pl. 9, Figs. 12, 13.
1990 *Ozarkodina excavata excavata* (BRANSON & MEHL) – UYENO, p. 91; Pl. 14, Fig. 18.
1994 *Ozarkodina excavata excavata* (BRANSON & MEHL) – MAWSON & TALENT, Fig. 13. F.
1995 *Ozarkodina excavata excavata* (BRANSON & MEHL) – FUREY-GREIG, Pl. 1, Fig. 12.
1995 *Ozarkodina excavata excavata* (BRANSON & MEHL) – SIMPSON & TALENT, p. 147; Pl. 9, Figs. 14–16 [cum syn.].
1999 *Ozarkodina excavata excavata* (BRANSON & MEHL) – TALENT & MAWSON, Pl. 6, Fig. 22; Pl. 11, Fig. 14; Pl. 12, Fig. 4.
2003 *Ozarkodina excavata excavata* (BRANSON & MEHL) – MAWSON, TALENT, MOLLOY & SIMPSON, Pl. 4, Figs. 5, 6?, 7–9.
2004 *Wurmiella excavata* (BRANSON & MEHL) – MURPHY, VALENZUELA-RÍOS & CARLS, Figs. 2.35, 2.36.
2005 *Ozarkodina excavata* (BRANSON & MEHL) – VON BITTER & PURNELL, Pl. 2, Figs. 14–17; Text-Figs. 2, 3.
2005 *Ozarkodina excavata excavata* (BRANSON & MEHL) – TALENT, SIMPSON, MOLLOY & MAWSON, p. 282; Fig. 6, D; Fig. 8, F.
2005 *Ozarkodina excavata excavata* (BRANSON & MEHL) – TROTTER & TALENT, p. 42; Pl. 18, Fig. 2.
2006 *Ozarkodina excavata excavata* (BRANSON & MEHL) – MATHIESON, p. 49; Pl. 12, Fig. J.

Description: Sa elements are trichonodellan (no posterior process developed). Usually they bear discrete, closely-spaced denticles, fused at their base in some specimens. The cross-section of nearly equal-sized denticles is elliptical to lenticular. The majority of obtained Sa elements have strongly broken processes, so that the precise number of denticles cannot be determined. The cusp is parallel-sided in posterior view, but starts tapering to a point in the upper half to one-third. At its base it is only a little wider than the maximum width of the raised margin of the basal cavity; the latter is rather broad and has a bluntly rounded apex. The lower margin is arched including an angle of about 110 degrees. In lower view, elements show a bowed outline with outer margins of the processes pointing posteriorly. Shallow open to nearly inverted basal grooves taper towards either end of each lateral process. The transverse axis seems rather straight but, when measured, angles sometimes are less than 180 degrees (with the anterior margin in front of the basal cavity resembling the vertex). A ledge along the base of the denticles is not developed.

Sb element (Pl. 13, Figs. 3, 5)

1962 *Plectospathodus extensus* RHODES – ETHINGTON & FURNISH, p. 1281; Pl. 173, Fig. 6.
1964 *Plectospathodus extensus* RHODES – WALLISER, p. 64; Pl. 8, Fig. 1; Pl. 30, Figs. 13, 14.
1971 *Plectospathodus extensus* RHODES – REXROAD & CRAIG, p. 698; Pl. 82, Figs. 1, 2.
1975 *Ozarkodina excavata excavata* (BRANSON & MEHL) – KLAPPER & MURPHY, p. 34; Pl. 6, Figs. 1, 2, 4.
1979 *Ozarkodina excavata excavata* (BRANSON & MEHL) – LANE & ORMISTON, p. 55; Pl. 9, Fig. 23.
1985a *Ozarkodina excavata excavata* (BRANSON & MEHL) – MASTANDREA, p. 250; Pl. 1, Fig. 15.
1986 *Ozarkodina excavata excavata* (BRANSON & MEHL) – MAWSON, p. 48; Pl. 4, Figs. 17–20.
1986 *Ozarkodina excavata* (BRANSON & MEHL) – MURPHY & CEBECIOĞLU, Fig. 1.12.
1987b *Ozarkodina excavata excavata* (BRANSON & MEHL) – MAWSON, p. 286; Pl. 31, Figs. 13, 14.
1989 *Ozarkodina excavata excavata* (BRANSON & MEHL) sensu JEPPSSON 1969 – JEPPSSON, p. 27; Pl. 3, Fig. 7.
1989 *Ozarkodina excavata excavata* (BRANSON & MEHL) – SORENTINO, p. 92; Pl. 1, Fig. 16.
1989 *Ozarkodina excavata excavata* (BRANSON & MEHL) – WILSON, p. 137; Pl. 9, Fig. 17.
1990 *Ozarkodina excavata excavata* (BRANSON & MEHL) – UYENO, p. 91; Pl. 14, Figs. 23?, 24?; Pl. 15, Fig. 17.
1994 *Ozarkodina excavata excavata* (BRANSON & MEHL) – MAWSON & TALENT, Fig. 13. G.
1995 *Ozarkodina excavata excavata* (BRANSON & MEHL) – SIMPSON & TALENT, p. 147; Pl. 9, Figs. 17–20 [cum syn.].
1999 *Ozarkodina excavata excavata* (BRANSON & MEHL) – TALENT & MAWSON, Pl. 6, Fig. 21.
2003 *Ozarkodina excavata excavata* (BRANSON & MEHL) – MAWSON, TALENT, MOLLOY & SIMPSON, Pl. 4, Figs. 13–15.
2004 *Wurmiella excavata* (BRANSON & MEHL) – MURPHY, VALENZUELA-RÍOS & CARLS, Fig. 2.29.
2004 *Ozarkodina excavata excavata* (BRANSON & MEHL) – SLAVÍK & HLADIL, Pl. 1, Figs. 17, 19?
2005 *Ozarkodina excavata* (BRANSON & MEHL) – VON BITTER & PURNELL, Pl. 1, Figs. 1–4; Pl. 3, Figs. 1–9; Text-Figs. 2, 3.

Description: Sb elements have a short anterior but a rather long posterior process (up to twice the length of the anterior one). The anterior process bears about 8 denticles, whereas the posterior one carries about 9 to 12 (in many specimens the posteriormost part of each process is broken, so that the exact number of denticles could not be counted). The blade is rather low, possessing no ledges. Denticles are discrete and closely spaced. Some elements have denticles that are fused at their base. They are needle-like with an elliptical cross-section, but generally tips are broken. Some elements bear a few smaller denticles on either side of the cusp. The cusp is inclined and pointed and about two-thirds the height of the blade. The lower margin is gently arched. The basal cavity is narrow with a lowly raised, bluntly rounded outer margin that reaches about one-third of the height of the blade in lateral view. The basal grooves start shallow with a inverted margin running towards the middle of each process, then becoming narrowly open or adpressed.

Sc element (Pl. 13, Figs. 8, 9)

1962 *Hindeodella equidentata* RHODES – ETHINGTON & FURNISH, p. 1267; Pl. 173, Fig. 2.
1964 *Hindeodella equidentata* RHODES – WALLISER, p. 36; Pl. 8, Fig. 3; Pl. 32, Fig. 11.
1966 *Hindeodella equidentata* RHODES – PHILIP, p. 445; Pl. 3, Fig. 1.
1975 *Ozarkodina excavata excavata* (BRANSON & MEHL) – KLAPPER & MURPHY, p. 34; Pl. 6, Fig. 3.
1979 *Ozarkodina excavata excavata* (BRANSON & MEHL) – LANE & ORMISTON, p. 55; Pl. 9, Fig. 19.
1985a *Ozarkodina excavata excavata* (BRANSON & MEHL) – MASTANDREA, p. 250; Pl. 1, Fig. 21.
1986 *Ozarkodina excavata excavata* (BRANSON & MEHL) – MAWSON, p. 48; Pl. 4, Figs. 21, 22.
1986 *Ozarkodina excavata excavata* (BRANSON & MEHL) – MURPHY & CEBECIOĞLU, Fig. 1.13.
1987b *Ozarkodina excavata excavata* (BRANSON & MEHL) – MAWSON, p. 286; Pl. 31, Figs. 15, 16.
1989 *Ozarkodina excavata excavata* (BRANSON & MEHL) – SORENTINO, p. 92; Pl. 1, Figs. 17, 18.
1989 *Ozarkodina excavata excavata* (BRANSON & MEHL) – WILSON, p. 137; Pl. 9, Fig. 18.
1990 *Ozarkodina excavata excavata* (BRANSON & MEHL) – UYENO, p. 91; Pl. 14, Fig. 25.
1994 *Ozarkodina excavata excavata* (BRANSON & MEHL) – MAWSON & TALENT, Fig. 13. H.
1995 *Ozarkodina excavata excavata* (BRANSON & MEHL) – SIMPSON & TALENT, p. 147; Pl. 9, Figs. 21–24 [cum syn.].
1999 *Ozarkodina excavata excavata* (BRANSON & MEHL) – TALENT & MAWSON, Pl. 6, Fig. 20; Pl. 12, Fig. 3.
2003 *Ozarkodina excavata excavata* (BRANSON & MEHL) – MAWSON, TALENT, MOLLOY & SIMPSON, Pl. 4, Figs. 10, 12.
2004 *Wurmiella excavata* (BRANSON & MEHL) – MURPHY, VALENZUELA-RÍOS & CARLS, Fig. 2.34.
2004 *Ozarkodina excavata excavata* (BRANSON & MEHL) – SLAVÍK & HLADIL, Pl. 1, Fig. 18.

2005 *Ozarkodina excavata* (Branson & Mehl) – von Bitter & Purnell, Pl. 1, Figs. 1–4; Pl. 3, Figs. 10–15; Text-Figs. 2, 3.
2005 *Ozarkodina excavata excavata* (Branson & Mehl) – Talent, Simpson, Molloy & Mawson, p. 282; Fig. 8, C.
2006 *Ozarkodina excavata excavata* (Branson & Mehl) – Mathieson, p. 49; Pl. 12, Figs. K-M.

Description: Elements bear 7 to 8 denticles on the anterior process and about 15 (or more) on the posterior process. The denticles are needle-like and elliptical in cross-section. Near the cusp they are somewhat smaller, but enlarged successively towards the distal ends. The posterior process is bowed and meets the anterior process including an angle between 90 and 100 degrees. The basal cavity is narrow and extends as an open basal groove to the posterior margin. By contrast the anterior basal groove becomes inverted immediately in front of the anterior margin of the cusp in lower view. In lateral view the posterior process is gently arched and seems slightly stepped, whereas the lower margin of the anterior process remains straight. The cusp is rather high and slightly inclined with an elliptical cross-section (tip generally broken). A ledge is developed only close to the cusp beneath the proximal 2 and 5 denticles.

M element (Pl. 12, Fig. 1; Pl. 14, Fig. 2)

1933 *Prioniodus excavatus* n. sp. Branson & Mehl, p. 45; Pl. 3, Figs. 7, 8.
1962 *Prioniodina bicurvata* (Branson & Mehl) – Ethington & Furnish, p. 1283; Pl. 173, Fig. 17.
1964 *Neoprioniodus excavatus* (Branson & Mehl) – Walliser, p. 49; Pl. 8, Fig. 4; Pl. 29, Fig. 26, Text-Fig. 5.c.
1971 *Neoprioniodus excavatus* (Branson & Mehl) – Bultynck, p. 3; Pl. 2, Fig. 11.
1971 *Neoprioniodus excavatus* (Branson & Mehl) – Rexroad & Craig, p. 692; Pl. 80, Figs. 6–9.
1975 *Ozarkodina excavata excavata* (Branson & Mehl) – Klapper & Murphy, p. 34; Pl. 6, Figs. 7–10.
?1975 *Synprioniodina bicurvata* (Branson & Mehl) – Telford, p. 70; Pl. 15, Figs. 6–11.
1979 *Ozarkodina excavata excavata* (Branson & Mehl) – Lane & Ormiston, p. 55; Pl. 9, Fig. 21.
1985a *Ozarkodina excavata excavata* (Branson & Mehl) – Mastandrea, p. 250; Pl. 1, Fig. 11?
1986 *Ozarkodina excavata excavata* (Branson & Mehl) – Mawson, p. 48; Pl. 4, Figs. 8, 9.
1986 *Ozarkodina excavata* (Branson & Mehl) – Murphy & Cebecioğlu, Fig. 1.23.
1987b *Ozarkodina excavata excavata* (Branson & Mehl) – Mawson, p. 286; Pl. 31, Fig. 10.
1989 *Ozarkodina excavata* (Branson & Mehl) sensu Jeppsson 1969 – Jeppsson, p. 27; Pl. 3, Fig. 8.
1989 *Ozarkodina excavata excavata* (Branson & Mehl) – Sorentino, p. 92; Pl. 1, Figs. 10, 11.
1989 *Ozarkodina excavata excavata* (Branson & Mehl) – Wilson, p. 137; Pl. 9, Figs. 14–16.
1990 *Ozarkodina excavata excavata* (Branson & Mehl) – Uyeno, p. 91; Pl. 8, Fig. 11; Pl. 14, Figs. 17?, 19?; Pl. 15, Fig. 15?
1995 *Ozarkodina excavata excavata* (Branson & Mehl) – Carey & Bolger, p. 79; Fig. 3G.
1995 *Ozarkodina excavata excavata* (Branson & Mehl) – Simpson & Talent, p. 147; Pl. 9, Figs. 12, 13 [cum syn.].
1995 *Ozarkodina excavata excavata* (Branson & Mehl) – Sloan, Talent, Mawson, Simpson, Brock, Engelbretsen, Jell, Aung, Pfaffenritter, Trotter & Withnall, Pl. 12, Fig. 18.
1999 *Ozarkodina excavata excavata* (Branson & Mehl) – Talent & Mawson, Pl. 4, Figs. 1, 4.
1999 *Ozarkodina excavata excavata* (Branson & Mehl) – Viira, Pl. 1, Fig. 4?
2003 *Ozarkodina excavata excavata* (Branson & Mehl) – Mawson, Talent, Molloy & Simpson, Pl. 4, Figs. 1–4.
2005 *Ozarkodina excavata* (Branson & Mehl) – von Bitter & Purnell, Pl. 3, Figs. 16–20; Text-Figs. 2, 3.
2005 *Ozarkodina excavata excavata* (Branson & Mehl) – Trotter & Talent, p. 42; Pl. 18, Fig. 8.
2006 *Ozarkodina excavata excavata* (Branson & Mehl) – Mathieson, p. 49; Pl. 12, Fig. N.

Description: Two different types of M elements were recognized, one type possessing a short anterior process bearing up to 3 denticles (Plate 12, Fig. 1); this feature is lacking on the other type. The posterior process includes numerous denticles (more than 13). Denticles are discrete (aligned to closely-spaced) and nearly equal-sized with an elliptical to lenticular cross-section. The cusp is very prominent and high. The inner lower margin below the cusp is curved, possessing a slightly angular vertex pointing downward (broadly V-shaped). The inner anterior lower margin is bent upward, whereas the posterior one is evenly curved downward. The basal cavity is wider beneath the cusp on the inner side and continues as a shallow open groove towards the posterior margin. The anterior basal groove is shallow proximally and narrows towards the tip along the raised anterior lower margin.

Remarks: The most distinctive feature discriminating M elements is the outline of the inner lower margin below the cusp and the adjacent anterior area. Walliser (1964) compared the differing shapes and concluded there were four types (Text-Fig. 5, therein).

Pa element

(Pl. 1, Fig. 3; Pl. 14, Fig. 2; Pl. 16, Figs. 1–7, 9; Pl. 17, Figs. 1–3, 5)

1933 *Ozarkodina simplex* n. sp. Branson & Mehl, p. 52; Pl. 3, Figs. 46, 47.
1962 *Spathognathodus dubius* n. sp. Ethington & Furnish, p. 1286; Pl. 172, Fig. 1.
1964 *Spathognathodus inclinatus inclinatus* (Rhodes) – Walliser, p. 76; Pl. 8, Fig. 6; Pl. 19, Figs. 6?, 8–11, 18?, 19?; Pl. 20, Fig. 18.
1966 *Spathognathodus inclinatus inclinatus* (Rhodes) – Philip, p. 450; Pl. 1, Figs. 30, 31, 34, 35, 37–39.
1971 *Ozarkodina simplex* Branson & Mehl – Rexroad & Craig, p. 694; Pl. 80, Figs. 26–31.
1975 *Ozarkodina excavata excavata* (Branson & Mehl) – Klapper & Murphy, p. 34; Pl. 6, Figs. 13–20.
1979 *Ozarkodina excavata excavata* (Branson & Mehl) – Lane & Ormiston, p. 55; Pl. 2, Figs. 30, 31; Pl. 9, Fig. 20.
1983 *Ozarkodina excavata* (Branson & Mehl) – Murphy & Matti, Pl. 1, Figs. 1, 2.
1985a *Ozarkodina excavata excavata* (Branson & Mehl) – Mastandrea, p. 250; Pl. 1, Figs. 17, 20?
1986 *Ozarkodina excavata excavata* (Branson & Mehl) – Mawson, p. 48; Pl. 4, Figs. 1?, 2–4.
1986 *Ozarkodina excavata* (Branson & Mehl) – Murphy & Cebecioğlu, Figs. 1.16–1.17; Text-Figs. 2, 3.
1987b *Ozarkodina excavata excavata* (Branson & Mehl) – Mawson, p. 286; Pl. 31, Fig. 11.
1989 *Ozarkodina excavata* (Branson & Mehl) sensu Jeppsson 1969 – Jeppsson, p. 27; Pl. 3, Fig. 6?
1989 *Ozarkodina excavata excavata* (Branson & Mehl) – Sorentino, p. 92; Pl. 1, Figs. 1–9, 19.
1989 *Ozarkodina excavata excavata* (Branson & Mehl) – Wilson, p. 137; Pl. 9, Figs. 1–7.
1990 *Ozarkodina excavata excavata* (Branson & Mehl) – Uyeno, p. 91; Pl. 3, Fig. 11; Pl. 8, Fig. 10; Pl. 14, Figs. 14–16, 31; Pl. 15, Fig. 16?
non 1992 *Ozarkodina excavata excavata* (Branson & Mehl) – Bardashev & Ziegler, Pl. 1, Figs. 1, 12.
1994 *Ozarkodina excavata excavata* (Branson & Mehl) – Mawson & Talent, Fig. 13. A, B.
1995 *Ozarkodina excavata excavata* (Branson & Mehl) – Colqhuoun, Pl. 1, Fig. 16.
1995 *Ozarkodina excavata excavata* (Branson & Mehl) – Furey-Greig, Pl. 1, Figs. 13, 14.
1995 *Ozarkodina excavata excavata* (Branson & Mehl) – Simpson & Talent, p. 147; Pl. 8, Figs. 16–25; Pl. 9, Figs. 1–6 [cum syn.].
1995 *Ozarkodina excavata excavata* (Branson & Mehl) – Sloan, Talent, Mawson, Simpson, Brock, Engelbretsen, Jell, Aung, Pfaffenritter, Trotter & Withnall, Pl. 12, Fig. 15.
1998 *Ozarkodina excavata* (Branson & Mehl) – Çapkinoğlu & Bektaş, p. 164; Pl. 1, Figs. 15, 16, 18–20, non Figs. 14, 17, 21–23.

1999 *Ozarkodina excavata* (BRANSON & MEHL) – BENFRIKA, p. 315; Pl. 1, Fig. 7.
1999 *Ozarkodina excavata excavata* (BRANSON & MEHL) – TALENT & MAWSON, Pl. 5, Figs. 1–4; Pl. 7, Fig. 14; Pl. 9, Fig. 8; Pl. 11, Figs. 12, 13; Pl. 12, Fig. 1.
1999 *Ozarkodina excavata* (BRANSON & MEHL) – VIIRA, Pl. 1, Figs. 1, 2.
2003 *Ozarkodina excavata excavata* (BRANSON & MEHL) – MAWSON, TALENT, MOLLOY & SIMPSON, Pl. 3, Figs. 1–14.
2004 *Wurmiella excavata* (BRANSON & MEHL) – MURPHY, VALENZUELA-RÍOS & CARLS, Figs. 2.30, 2.31, 2.33.
2004b *Ozarkodina excavata excavata* (BRANSON & MEHL) – SLAVÍK, Pl. 1, Figs. 10, 11.
2004 *Ozarkodina excavata excavata* (BRANSON & MEHL) – SLAVÍK & HLADIL, Pl. 1, Fig. 14.
2005 *Ozarkodina excavata* (BRANSON & MEHL) – VON BITTER & PURNELL, Pl. 1, Figs. 5, 6; Pl. 2, Figs. 1–8; Text-Figs. 2, 3.
2005 *Ozarkodina excavata excavata* (BRANSON & MEHL) – TALENT, SIMPSON, MOLLOY & MAWSON, p. 282; Fig. 8, D.
2005 *Ozarkodina excavata excavata* (BRANSON & MEHL) – TROTTER & TALENT, p. 42; Pl. 18, Fig. 9.
2006 *Ozarkodina excavata excavata* (BRANSON & MEHL) – MATHIESON, p. 49; Pl. 12, Figs. A-H.

Description: Specimens have a rather long blade bearing 15 to 20 denticles. Denticles are discrete, but variable in shape, stout to palisade-like. They are more or less of equal height with an oval to elliptical cross-section. Some specimens have a few denticles enlarged but not following a particular pattern. The cusp usually is similar in size and shape to the denticles. The blade axis is straight or arched. A few elements show a slight twisting of the distal parts of the blade. Ledges are not or weakly developed, becoming more prominent among specimens in higher stratigraphic position. The lower margin is straight to stepped. The basal cavity is relatively small and has a position centred or posterior mid-length. The platform lobes are asymmetrical with the inner lobe more expanded and inflated so that the basal cavity is visible in lateral view on the inner side. In some specimens the outer margin of the platform lobes tapers gradually towards the posterior margin in lower view. Usually both lobes have a smooth surface, but a few elements developed a weak shoulder on the inner one. The basal cavity is moderately deep with an open anterior basal groove that can become adpressed towards the anterior margin, and an open posterior basal groove which tends to be inverted distally.

Pb element (Pl. 14, Figs. 3–11)

1962 *Ozarkodina media* WALLISER – ETHINGTON & FURNISH, p. 1278; Pl. 173, Fig. 19.
1964 *Ozarkodina media* WALLISER – WALLISER, p. 58; Pl. 8, Fig. 5; Pl. 26, Figs. 20, 21, 23, 24, 25, 28?
non 1966 *Ozarkodina media* WALLISER – CLARK & ETHINGTON, p. 681; Pl. 82, Fig. 25.
1966 *Ozarkodina media* WALLISER – PHILIP, p. 447; Pl. 1, Figs. 29, 32, 33.
1971 *Ozarkodina media* WALLISER – REXROAD & CRAIG, p. 693; Pl. 80, Figs. 22–24.
1975 *Ozarkodina excavata excavata* (BRANSON & MEHL) – KLAPPER & MURPHY, p. 34; Pl. 6, Figs. 11, 12.
1979 *Ozarkodina excavata excavata* (BRANSON & MEHL) – LANE & ORMISTON, p. 55; Pl. 9, Fig. 18.
1985a *Ozarkodina excavata excavata* (BRANSON & MEHL) – MASTANDREA, p. 250; Pl. 1, Fig. 19?
1986 *Ozarkodina excavata excavata* (BRANSON & MEHL) – MAWSON, p. 48; Pl. 4, Figs. 5–7.
1986 *Ozarkodina excavata* (BRANSON & MEHL) – MURPHY & CEBECIOĞLU, Fig. 1.10.
1987b *Ozarkodina excavata excavata* (BRANSON & MEHL) – MAWSON, p. 286; Pl. 31, Fig. 12.
1989 *Ozarkodina excavata excavata* (BRANSON & MEHL) – SORENTINO, p. 92; Pl. 1, Fig. 12.
1989 *Ozarkodina excavata excavata* (BRANSON & MEHL) – WILSON, p. 137; Pl. 9, Figs. 8–11.
1990 *Ozarkodina excavata excavata* (BRANSON & MEHL) – UYENO, p. 91; Pl. 3, Fig. 12; Pl. 8, Fig. 7; Pl. 14, Fig. 11; Pl. 15, Fig. 18.
1994 *Ozarkodina excavata excavata* (BRANSON & MEHL) – MAWSON & TALENT, Fig. 13. C, D.
1995 *Ozarkodina excavata excavata* (BRANSON & MEHL) – CAREY & BOLGER, p. 79; Fig. 3H.
1995 *Ozarkodina excavata excavata* (BRANSON & MEHL) – SIMPSON & TALENT, p. 147; Pl. 9, Figs. 7–11 [cum syn.].
1999 *Ozarkodina excavata excavata* (BRANSON & MEHL) – TALENT & MAWSON, Pl. 4, Fig. 3; Pl. 6, Fig. 19; Pl. 9, Fig. 9; Pl. 12, Fig. 2.
1999 *Ozarkodina excavata* (BRANSON & MEHL) – VIIRA, Pl. 1, Fig. 3.
2003 *Ozarkodina excavata excavata* (BRANSON & MEHL) – MAWSON, TALENT, MOLLOY & SIMPSON, Pl. 3, Figs. 15–19.
2004 *Wurmiella excavata* (BRANSON & MEHL) – MURPHY, VALENZUELA-RÍOS & CARLS, Fig. 2.32.
2004 *Ozarkodina excavata excavata* (BRANSON & MEHL) – SLAVÍK & HLADIL, Pl. 1, Fig. 15?
2005 *Ozarkodina excavata* (BRANSON & MEHL) – VON BITTER & PURNELL, Pl. 2, Figs. 9–13; Text-Figs. 2, 3.
2005 *Ozarkodina excavata excavata* (BRANSON & MEHL) – TROTTER & TALENT, p. 42; Pl. 18, Fig. 7.
2006 *Ozarkodina excavata excavata* (BRANSON & MEHL) – MATHIESON, p. 49; Pl. 12, Fig. I.

Description: Elements consist of two long processes with a nearly straight axis. The anterior process is about one-third to half the length of the posterior one, bearing 4 to 9 denticles. The posterior process has 6 to 14 denticles. Generally the blade is rather low with stout to palisade-like denticles possessing free-pointed tips. The cross-section of the denticles is elliptical, but can be lenticular in specimens with a rather adpressed blade. In some elements the base of the denticles on the posterior process is located a little lower than along the anterior one. A weak ledge (or none) is developed near the denticle's base. The cusp is slightly inclined oval to elliptical in cross-section and usually two-thirds longer compared to the height of the denticles. The lower margin is straight or gently curved including an angle of 113 to 142 degrees between the anterior and posterior processes. The basal platform is rounded, but asymmetrical with the inner lobe higher, so that the basal cavity is visible in lateral view on the inner side. The basal pit is located beneath the centre of the cusp. The basal grooves remain open, tapering towards either margin in lower view. In some specimens with an adpressed blade both basal grooves are open proximally becoming adpressed distally.

Remarks: Though some specimens have a higher number of denticles, the ratio (denticles/mm) calculated is closer to values of *Ozarkodina excavata excavata* rather than of *O. excavata tuma*. Such elements (e.g.: Plate 14, Fig. 3) possibly represent transitional forms, but remain within the assigned group, because they lack the prominent ledge typical for *O. excavata tuma*.

Ozarkodina aff. *O. excavata tuma* MURPHY & MATTI, 1983

Pl. 12, Figs. 9, 10; Pl. 13, Figs. 1, 2, 13; Pl. 16, Figs. 8, 10

Material: 18 specimens.

Sa element (Pl. 12, Figs. 9, 10)

aff. 2004 *Wurmiella tuma* (MURPHY & MATTI) – MURPHY, VALENZUELA-RÍOS & CARLS, p. 11; Figs. 2.27, 2.28.

Description: Sa elements are trichonodellan with discrete, closely-spaced denticles, which are needle-like with elliptical to lenticular cross-section. Denticles are of equal size, except some specimens that have smaller intercalated denticles, which are not alternating along the entire process. The cusp is parallel-sided in posterior view, but starts tapering to a point in the upper half to one-third. Processes bear about 9 denticles. The lower margin is arched, including an angle of about 135 degrees. In lower view, elements show a bowed outline with outer margins of each process pointing in posterior direction. Open basal grooves taper towards either end of each lateral process becoming adpressed distally. The transverse axis seems rather straight, but when measured angles can include 155 to 165 degrees (with the anterior margin in front of the basal cavity resembling the vertex). The basal cavity is rather narrow with a raised posterior margin with a rounded apex (lancet-like). The raised part of the margin is about a half to two-thirds of the width of the lower part of the cusp. In some specimens the basal pit is triangular and of moderate depth, whereas others possess only a shallow pit. A ledge along the base of the denticles is developed in some elements, extending from near the cusp to the third to sixth denticle.

Sb element (Pl. 13, Figs. 1, 2)

aff. 2004 *Wurmiella tuma* (MURPHY & MATTI) – MURPHY, VALENZUELA-RÍOS & CARLS, p. 11; Figs. 2.23, 2.24.

Description: Obtained elements have a short anterior process with more than 6 denticles (minimum number of denticles resulting from the high degree of breakage). The posterior process is up to twice the length of the anterior one. The central axis is straight to arched. The blade is rather low possessing no or only weakly developed ledges beneath the denticles proximal to the cusp. Denticles are discrete and usually closely spaced and sometimes fused at their base. They are needle-like with elliptical to lenticular cross-section. Some elements bear one or two smaller denticles on either side of the cusp. The cusp is inclined and pointed and about two-thirds the height of the blade. The lower margin is slightly arched. The basal cavity is narrow with a low, raised outer margin of which the apex reaches about a quarter of the height of the blade. The basal margin remains uninverted with open basal grooves that extend about half the length along the posterior process before becoming adpressed (anterior extent is questionable due to breakage).

Sc element (Pl. 13, Fig. 13)

aff. 2004 *Wurmiella tuma* (MURPHY & MATTI) – MURPHY, VALENZUELA-RÍOS & CARLS, p. 11; Figs. 2.25, 2.26.

Remarks: The figured element is similar in shape to those assigned to *Ozarkodina excavata excavata*, differing only in few, but distinct features. The angle included between posterior and anterior process is wider than 150 degrees. The lower margin of the posterior process is slightly down curving. The basal cavity is narrow, but contrary to *Ozarkodina excavata excavata*, it extends along either side as open basal groove becoming adpressed distally. The ledge along the posterior process is more prominent.

Pa element (Pl. 16, Figs. 8, 10)

aff. 1983 *Ozarkodina excavata* subspecies *tuma* n. subsp. MURPHY & MATTI, p. 7; Pl. 1, Figs. 3–9.
aff. 1986 *Ozarkodina tuma* MURPHY & MATTI – MURPHY & CEBECIOĞLU, Figs. 1.1–1.7; Text-Figs. 2, 3.
aff. 2004 *Wurmiella tuma* (MURPHY & MATTI) – MURPHY, VALENZUELA-RÍOS & CARLS, p. 11; Figs. 2.16–2.19.

Description: Some specimens of the *excavata* group show a higher number of denticles, a more pronounced ledge and small but shouldered, asymmetrical platform lobes. The lower profile is stepped (Plate 16, Fig. 8) or nearly straight (Plate 16, Fig. 10). Values of the calculated ratio (denticles/mm) of the few Pa elements obtained, cover an intermediate position between both clusters (*Ozarkodina excavata excavata* and *O. excavata tuma*), but tend to be closer to the lower limit of what is classified as *Ozarkodina tuma* (compare scatter diagram, MURPHY & CEBECIOĞLU, 1986: Fig. 2).

Remarks: Elements of this species differ from *Ozarkodina excavata excavata* in possessing a markedly high ratio of denticle number in relation to blade length and from *Ozarkodina wurmi* in having a straight or stepped lower profile.

Ozarkodina excavata ssp.

Pl. 12, Fig. 2

Material: 10 specimens.

M element (Pl. 12, Fig. 2)

1994 *Ozarkodina excavata excavata* (BRANSON & MEHL) – MAWSON & TALENT, Fig. 13. E.

Remarks: The obtained elements are very similar to those assigned to *Ozarkodina excavata excavata* (BRANSON & MEHL, 1933), but differ in possessing denticles alternating in size along the posterior process. The sequence starts with one denticle of average size alternating with a small one. Variation in denticle size is restricted to the proximal half of the posterior process. Denticles along the distal half of the process are again rather equal in size. The posterior process bears between 17 and 20 denticles.

Following the proposal of MURPHY et al. (2004, p. 10, final paragraph of the first column, therein), non-platform elements assigned to the apparatus of *'Wurmiella'* (= *Ozarkodina excavata* ssp.) generally include equidentate denticulation. Intercalations of single smaller denticles may occur in this nominal genus. The illustrated element shows denticles of alternating size, but in accordance with the distinct outline of the inner basal margin it is assigned to *Ozarkodina excavata* ssp.

Ozarkodina pandora alpha morph MURPHY, MATTI & WALLISER, 1981

Pl. 19, Figs. 1–3

Material: 7 specimens.

Pa element (Pl. 19, Figs. 1–3)

1981 *Ozarkodina pandora* alpha morphotype MURPHY, MATTI & WALLISER, p. 763; Pl. 1, Figs. 1–13, 15–16, 22–24; Pl. 2, Fig. 13; Pl. 3, Figs. 3–5; Text-Figs. 4, 8, 9, 11, 12.
1985 *Ozarkodina pandora* alpha morphotype MURPHY, MATTI & WALLISER – CHLUPÁČ, LUKEŠ, PARIS & SCHÖNLAUB, Pl. 2, Figs. 2, 11, 18.
1985b *Ozarkodina* cf. *pandora* alpha morphotype MURPHY, MATTI & WALLISER – SCHÖNLAUB, Pl. 2, Figs. 6?, 7?, 8, 9, 11, 15.
aff. 1987 *Ozarkodina pandora* MURPHY, MATTI & WALLISER – WEDDIGE, Text-Fig. 2.
1989 *Ozarkodina pandora* alpha morph MURPHY, MATTI & WALLISER – SORENTINO, p. 94; Pl. 3, Fig. 16?
1989 *Ozarkodina pandora* MURPHY, MATTI & WALLISER – WILSON, p. 139; Pl. 12, Figs. 1, 4, 5.
1998 *Ozarkodina pandora* MURPHY, MATTI & WALLISER – ÇAPKINOĞLU & BEKTAŞ, p. 164; Pl. 2, Figs. 12–14.
1999 *Ozarkodina pandora* alpha morphotype MURPHY, MATTI & WALLISER – BENFRIKA, p. 315; Pl. 1, Figs. 16–18.
1999 *Ozarkodina pandora* alpha morph MURPHY, MATTI & WALLISER – TALENT & MAWSON, Pl. 8, Figs. 8, 10, non Fig. 9.
2004 *Ozarkodina pandora* alpha morphotype MURPHY, MATTI & WALLISER – FARRELL, p. 972; Pl. 6, Figs. 14–15.
2004 *Ozarkodina pandora* alpha morphotype MURPHY, MATTI & WALLISER – SLAVÍK & HLADIL, p. 149; Pl. 1, Fig. 11.

Description: Elements have a nearly straight to slightly arched axis. The blade usually has fused to unspaced but discrete denticles with pointed tips; these have a lenticular to oval cross-section. Denticles and cusp are of uniform height (except for one specimen on Plate 19, Fig. 1) forming a nearly horizontal upper profile with their tips pointing posteriorly. The anterior margin is slightly rounded. The lower margin is stepped to straight. The platform covers more than half the entire blade length. Two unequally wide lobes are visible in upper view. One of them is rounded but narrow compared with a much larger second lobe. The latter expands abruptly anterior to the middle of the blade, continuing with its outer margin parallel to the blade and starting to taper gradually to the posterior margin somewhat behind the cusp. Both lobes are unornamented. The basal cavity is medium to shallow and remains open to the posterior tip of the blade. The anterior groove is narrow open to adpressed.

Remarks: The specimen on Plate 19, Fig. 2 seems to be an early representative of *O. pandora* alpha morph according to the outline of the lateral profile of the blade, which is not as low as it is common for this species. On the other hand the platform is broadly expanded and tapers to the posterior margin, standing in contrast to the platform development of its progenitor *Ozarkodina remscheidensis remscheidensis*.

The specimen on Plate 19, Fig. 1 possesses needle-like denticles of equal size, but has an enlarged cusp, which differs from the original description of MURPHY et al. (1981). All denticles point anteriorly. The deformed specimen may be the result of shear stress within a small faulted area of the outcrop, from which the figured element was obtained. The basal cavity seems typical for the alpha morph, but has a more spear-like outline, a feature that is diagnostic for the pi morph (MURPHY & MATTI, 1983). Following the remarks of MURPHY & MATTI, the pi morph is intermediate in form between the alpha and zeta morphs that occurs in the lower part of the *pesavis* Zone. The specimen from the Seewarte was found in the late *delta* Zone from a bed a few metres below the first occurrence of *Pedavis* sp. (M2 elements only). Compared to figured type material (MURPHY & MATTI, 1983: Plate 1, Figs. 10–24) the specimen herein is regarded as closer to the alpha morph with features of the pi morph.

Ozarkodina aff. *O. pandora* beta morph MURPHY, MATTI & WALLISER, 1981

Pl. 19, Fig. 13

Material: 2 specimens.

Pa element (Pl. 19, Fig. 13)

aff. 1981 *Ozarkodina pandora* beta morphotype MURPHY, MATTI & WALLISER, p. 763; Pl. 1, Figs. 17–21, 25–31, 36–38; Text-Figs. 4, 8, 9, 11.

aff. 1985 *Ozarkodina pandora* beta morphotype MURPHY, MATTI & WALLISER – CHLUPÁČ, LUKEŠ, PARIS & SCHÖNLAUB, Pl. 2, Figs. 8, 10, 12.

aff. 1989 *Ozarkodina pandora* MURPHY, MATTI & WALLISER – SORENTINO, p. 94; Pl. 3, Fig. 10?

aff. 1989 *Ozarkodina pandora* beta morph MURPHY, MATTI & WALLISER – WILSON, p. 139; Pl. 12, Figs. 2, 3.

aff. 1998 *Ozarkodina pandora* beta morfotipi MURPHY, MATTI & WALLISER – ÇAPKINOĞLU & BEKTAŞ, p. 164; Pl. 2, Figs. 15–18.

Description: A fragmented Pa element with a low adpressed blade with widely spaced denticles and a stepped lower margin. Denticles are discrete and nearly triangular in lateral view with subcircular to lenticular cross-section. The platform is rounded with its centre located slightly anterior to the cusp. Lobes are of unequal width, with the wider one bearing a ridge linked with the blade. Both lobes expand abruptly in the anterior half of the blade and taper with an only narrowly expanded platform margin below the tip of the cusp (in upper view) along the posterior process extending to the posterior margin. The basal cavity is shallow. Basal grooves are open proximally and run adpressed towards either margin.

Remarks: Considering that the platform lobes taper to a point at the posterior margin, with one lobe ornamented, and with the presence of discrete, widely spaced denticles, it is concluded, that the element does not belong to the *eosteinhornensis* lineage (MURPHY et al., 2004: Fig. 1). The specimen shows strong affinity to Pa elements of *O. pandora* beta morph. Due to breakage of the anterior and posterior portions of the blade and the evidence, that the specimen occurs within the *delta* Zone, it is not assigned to the suggested morphotype with certainty.

Ozarkodina cf. *O. pandora* zeta morph MURPHY, MATTI & WALLISER, 1981

Pl. 20, Fig. 11

Material: 1 specimen.

Pa element (Pl. 20, Fig. 11)

cf. 1981 *Ozarkodina pandora* zeta morphotype MURPHY, MATTI & WALLISER, p. 765; Pl. 2, Fig. 20; Text-Fig. 4.

cf. 1985 *Ozarkodina pandora* zeta morphotype MURPHY, MATTI & WALLISER – CHLUPÁČ, LUKEŠ, PARIS & SCHÖNLAUB, Pl. 2, Figs. 6, 7, 9.

cf. 1989 *Ozarkodina pandora* zeta morph MURPHY, MATTI & WALLISER – MURPHY, Fig. 1.1.

cf. 2003 *Ozarkodina pandora* zeta morphotype MURPHY, MATTI & WALLISER – FARRELL, p. 136; Pl. 7, Figs. 15–19.

Remarks: The obtained specimen differs from *O. pandora* zeta morph and morphs of *Eognathodus sulcatus* in exhibiting only a small platform with one lobe being square and the other more triangular (if not broken?). The blade is low in lateral view with one process entirely broken off. The main axis is arched. Due to the bad condition of the element it is questionable whether the remaining process is the anterior one. Five broken denticles possibly with unfused tips (counted from the one end of the remaining process in the direction to the platform) are followed by a ridge consisting of 4 to 5 fused denticles. Fusion of denticles around the mid-blade is characteristic for Pa elements of *O. pandora* zeta morph. The most proximal denticle of the fused ridge-like part of the carina seems to join the cusp (close to where the lateral margin of the square-shaped lobe, pointing to the preserved process, meets the blade) with a slight offset in upper view. This feature is diagnostic for *Eognathodus irregularis* (DRUCE, 1971), but the obtained specimen lacks the irregular nature of denticulation along the blade. The lowermost part of the blade along the area close to the straight lower margin is adpressed. Both platform lobes are free of any ornament.

Ozarkodina aff. *O. paucidentata* MURPHY & MATTI, 1983

Pl. 18, Fig. 10

Material: 1 specimen.

Pa element (Pl. 18, Fig. 10)

aff. 1977 *Ozarkodina remscheidensis remscheidensis* (ZIEGLER) α morphotype CHATTERTON & PERRY – CHATTERTON & PERRY, p. 786; Pl. 3, Figs. 28–35; Pl. 4, Figs. 31, 33–36.

aff. 2003 *Ozarkodina* sp. cf. *O. paucidentata* MURPHY & MATTI – MAWSON, TALENT, MOLLOY & SIMPSON, p. 93; Pl. 4, Figs. 19, 20.

Description: The element has a straight axis with 6 denticles on the anterior and 5 denticles on the posterior process. Denticles are blunt and fused at the base. The cusp is enlarged, triangular in lateral view with a rounded tip. Mid-blade denticles including the cusp show a sub-rounded cross-section which changes to lenticular shape among the distal denticles. The upper profile of the anterior process is slightly curved resulting in somewhat larger denticles distally. The posterior blade is about one-third lower compared to the height of the anterior blade. Denticles are smaller forming a rather straight upper profile. A weak pinch zone is developed in the lower part of the blade. The basal platform is located posterior to mid-length, possessing broad, subequal rounded lobes. The anterior and posterior margin of the platform lobes close to the blade taper distally, except that the basal walls of the posterior blade are wider in lower view. The proximal basal walls of the anterior platform margin decline faster somewhat below the second denticle (in front of the cusp) with an anterior basal groove that narrows in the middle part of the anterior process, becoming adpressed towards the distal end.

Remarks: In contrast with the specimens presented by KLAPPER & MURPHY (1975) referred to *Ozarkodina* n. sp. E, which later were renamed by MURPHY & MATTI (1983), the obtained element lacks the distinct squeeze-like proximal posterior process. The diagnostic paucity of denticles of the posterior process is less well developed compared to the figured type material. The obtained Pa element is similar to that illustrated by MAWSON et al. (2003). The authors decided to use open nomenclature due to the differing shape of the denticles. CHATTERTON & PERRY (1977) described a “new form α” of *Ozarkodina remscheidensis remscheidensis*, of which Pa elements show a prominent cusp and a lowered profile of the posterior process, but their specimens differ from the present one by possessing more discrete and needle-like denticles and slightly inclined lower margins of both processes.

Ozarkodina aff. *O. remscheidensis eosteinhornensis* (WALLISER, 1964) alpha morph MURPHY, VALENZUELA-RÍOS & CARLS, 2004

Pl. 20, Fig. 10

Material: 1 specimen.

Pa element (Pl. 20, Fig. 10)

aff. 1964 *Spathognathodus steinhornensis eosteinhornensis* n. ssp. WALLISER, p. 85; Pl. 20, Figs. 19, 22.

aff. 1989 *Ozarkodina S. eosteinhornensis* (WALLISER) sensu JEPPSSON 1975 – JEPPSSON, p. 28; Pl. 2, Figs. 1–3.

aff. 2004 *W eosteinhornensis* (WALLISER) – MURPHY, VALENZUELA-RÍOS & CARLS, p. 16; Figs. 2.45–2.47; Figs. 3.33–3.35.

Description: The obtained material is broken with only the part of the mid blade preserved. In lateral view a high denticle is aligned with the blade developed on one platform lobe. Such an alignement is not visible on the opposite side. Four denticles (two of them complete) are discernible, fused at the base, and possessing low, bluntly rounded tips and a nearly oval cross-section. The proximal basal grooves are shallow. All other distinctive features remain unclear due to breakage.

Remarks: The remaining part of the Pa element is nearly identical with the elements figured by WALLISER, 1964 (Plate 20, Figs. 19, 20). According to the stratigraphic position (*detorta* Zone), and the fact that one of the platform lobes is ornamented in a specific way, a close relation to the former *Ozarkodina steinhornensis eosteinhornensis* is concluded. This taxon was reinvestigated by MURPHY et al. (2004) and included in their newly established “New Genus W” as *“W eosteinhornensis”*. They discriminated three morphotypes in *“W eosteinhornensis”* (alpha, beta and tau morphs). The described specimen resembles the alpha morph by possessing a certain denticle fusion and a conspicuous denticle on one of the platform lobes.

Ozarkodina aff. *O. remscheidensis eosteinhornensis* (WALLISER, 1964) beta morph MURPHY, VALENZUELA-RÍOS & CARLS, 2004

Pl. 18, Fig. 2

Material: 3 specimens.

Pa element (Pl. 18, Fig. 2)

aff. 2004 *W eosteinhornensis* (WALLISER) – MURPHY, VALENZUELA-RÍOS & CARLS, p. 16.

Description: The blade axis is gently arched with bluntly rounded denticles that are nearly of uniform height with elliptical cross-section. Some differ in being somewhat wider at the base. The cusp is not enlarged and is very similar in shape to the other denticles. The lower margin is nearly straight. The basal platform is asymmetrical and seems to be positioned posterior the mid-length. One of the lobes is subrectangular and wider than broad, whereas the second lobe is rounded to heart-shaped. Both lobes are unornamented. The anterior and posterior margins of the platform lobes are not constricted where they join the blade. A weak pinch zone is developed anteriorly and posteriorly of the platform. Each of the basal grooves remains open proximally. The anterior one tapers to a point distally.

Remarks: The material is very similar to *Ozarkodina remscheidensis baccata* described by MILLER & ALDRIDGE, 1997 (Plate 1, Figs. 9, 12) from the Upper Ludlow of the Welsh Borderland and Wales. It differs slightly in outline and position of the platform. Due to the broken posterior process, it is unclear whether the specimen possessed a step-like extension beyond the last denticle or not, and how the posterior basal groove continued distally. The Pa element seems closely related to *O. r. eosteinhornensis* mainly because of the relatively even denticulation, the presence of an asymmetrical platform with one of the lobes being subrectangular, as well as regarding its stratigraphic position (lower? *delta* Zone). Nevertheless it could not be assigned to *Ozarkodina remscheidensis eosteinhornensis* with certainty due to the margin of the platform being not constricted where the lobes join the blade (MURPHY et al., 2004: page 16). As both platform lobes remain unornamented, relationship to the beta morph is suggested.

Ozarkodina remscheidensis remscheidensis (ZIEGLER, 1960)

Pl. 12, Figs. 5, 6, 8; Pl. 17, Figs. 6–13; Pl. 18, Fig. 1

General Remarks: MURPHY et al. (2004) figured all elements suggested for the apparatus of their new genus *‘Zieglerodina’*. They assigned only elements obtained from beds e and f of the section at Untenrüden (Rhenish Slate Mountains) to *‘Zieglerodina remscheidensis’*. Similar elements from bed 40 of the Cellon section (Carnic Alps) and from glacial erratic boulders (northern Germany) were classified only at genus-level.

According to the high variability of some features within elements of the *O. remscheidensis* ssp. material from the type locality, morphological differences in elements of the apparatus from the Carnic Alps are possibly of intraspecific nature compared with the assemblage in MURPHY et al. (2004). Specimens from the Seewarte are therefore left within *Ozarkodina remscheidensis remscheidensis*.

Material: 229 specimens.

Sa element (Pl. 12, Fig. 8)

1979 *Ozarkodina remscheidensis remscheidensis* (ZIEGLER) – LANE & ORMISTON, p. 57; Pl. 1, Fig. 36.

1980 *Ozarkodina remscheidensis* (ZIEGLER) – PICKETT, Fig. 13.A.

1980 *Ozarkodina remscheidensis remscheidensis* (ZIEGLER) – SERPAGLI & MASTANDREA, p. 39; Pl. 1, Fig. 6.

1985a *Ozarkodina remscheidensis remscheidensis* (ZIEGLER) – MASTANDREA, p. 252; Pl. 1, Fig. 7.
1986 *Ozarkodina remscheidensis remscheidensis* (ZIEGLER) – MAWSON, p. 49; Pl. 6, Figs. 14–17.
1989 *Ozarkodina remscheidensis remscheidensis* (ZIEGLER) – SORENTINO, p. 93; Pl. 3, Figs. 15, 17.
1989 *Ozarkodina remscheidensis remscheidensis* (ZIEGLER) – WILSON, p. 138; Pl. 11, Fig. 15.
1990 *Ozarkodina remscheidensis remscheidensis* (ZIEGLER) – UYENO, p. 93; Pl. 5, Fig. 36?; Pl. 16, Fig. 37?; Pl. 17, Fig. 30 [cum syn.].
1995 *Ozarkodina remscheidensis remscheidensis* ZIEGLER – COLQUHOUN, Pl. 3, Fig. 13.
2003 *Ozarkodina remscheidensis remscheidensis* (ZIEGLER) – MAWSON, TALENT, MOLLOY & SIMPSON, p. 90; Pl. 2, Fig. 16 [cum syn.].
2004 *Zieglerodina remscheidensis* (ZIEGLER) – MURPHY, VALENZUELA-RÍOS & CARLS, p. 13; Fig. 3.20.
2004 *Zieglerodina* sp. MURPHY, VALENZUELA-RÍOS & CARLS, p. 12; Figs. 3.30, 3.31.

Description: The cusp is subcircular to rather triangular with rounded edges in cross-section. The anterior margin of the cusp is recessed, meeting the proximal parts of both processes not in a line in upper view. No posterior process is developed. A short, rounded, not raised margin of the small basal cavity extends posteriorly. Each process bears 5 to 7 denticles of almost uniform size and shape. The lower margin of both processes includes an angle of nearly 90 degrees.

Remarks: In the description of Sa elements assigned to this genus, MURPHY et al. (2004) pointed out, that the blades are short but high, including an angle of 65 to 80 degrees. These features differ slightly in some of the obtained specimens. The blade is not very high and the angle included reaches up to a maximum of 90 degrees. Nonetheless the distinct recessed position of the cusp is visible in all specimens.

Sb element

1979 *Ozarkodina remscheidensis remscheidensis* (ZIEGLER) – LANE & ORMISTON, p. 57; Pl. 1, Fig. 35.
1980 *Ozarkodina remscheidensis remscheidensis* (ZIEGLER) – SERPAGLI & MASTANDREA, p. 39; Pl. 1, Fig. 10.
1985a *Ozarkodina remscheidensis remscheidensis* (ZIEGLER) – MASTANDREA, p. 252; Pl. 1, Fig. 12.
1986 *Ozarkodina remscheidensis remscheidensis* (ZIEGLER) – MAWSON, p. 49; Pl. 6, Fig. 18.
1989 *Ozarkodina remscheidensis remscheidensis* (ZIEGLER) – SORENTINO, p. 93; Pl. 4, Figs. 4–6.
1989 *Ozarkodina remscheidensis remscheidensis* (ZIEGLER) – WILSON, p. 138; Pl. 11, Fig. 14.
1990 *Ozarkodina remscheidensis remscheidensis* (ZIEGLER) – UYENO, p. 93; Pl. 5, Fig. 31; Pl. 16, Fig. 39?; Pl. 17, Fig. 31 [cum syn.].
1999 *Ozarkodina remscheidensis remscheidensis* (ZIEGLER) – TALENT & MAWSON, Pl. 12, Fig. 14.
2003 *Ozarkodina remscheidensis remscheidensis* (ZIEGLER) – MAWSON, TALENT, MOLLOY & SIMPSON, p. 90; Pl. 2, Fig. 17 [cum syn.].
2004 *Zieglerodina remscheidensis* (ZIEGLER) – MURPHY, VALENZUELA-RÍOS & CARLS, p. 13; Figs. 3.21–3.23.

Description: Elements have a long posterior process bearing large denticles alternating with sets of 2 to 3 small denticles. Denticles are discrete with pointed tips and elliptical to lenticular cross-section. No ledge is developed below the base of the denticles. The blade is slightly undulating with a somewhat wavy lower margin. The basal cavity is small and the basal grooves are shallow proximally, becoming inverted distally.

Remarks: Elements differ from those assigned to *O. r. eosteinhornensis* by lacking pronounced ledges, but exhibit undulating blades with irregularly spaced and alternating denticles.

Sc element

1980 *Ozarkodina remscheidensis* (ZIEGLER) – PICKETT, Fig. 13.C.
1980 *Ozarkodina remscheidensis remscheidensis* (ZIEGLER) – SERPAGLI & MASTANDREA, p. 39; Pl. 1, Fig. 11.
1985a *Ozarkodina remscheidensis remscheidensis* (ZIEGLER) – MASTANDREA, p. 252; Pl. 1, Fig. 6.
1986 *Ozarkodina remscheidensis remscheidensis* (ZIEGLER) – MAWSON, p. 49; Pl. 6, Figs. 19, 20.
1989 *Ozarkodina remscheidensis remscheidensis* (ZIEGLER) – SORENTINO, p. 93; Pl. 4, Figs. 1–3, 7.
1989 *Ozarkodina remscheidensis remscheidensis* (ZIEGLER) – WILSON, p. 138; Pl. 11, Fig. 16.
1990 *Ozarkodina remscheidensis remscheidensis* (ZIEGLER) – UYENO, p. 93; Pl. 5, Fig. 32; Pl. 16, Fig. 40?; Pl. 17, Fig. 29 [cum syn.].
1995 *Ozarkodina remscheidensis remscheidensis* ZIEGLER – COLQUHOUN, Pl. 3, Fig. 2.
1995 *Ozarkodina remscheidensis remscheidensis* (ZIEGLER) – SLOAN, TALENT, MAWSON, SIMPSON, BROCK, ENGELBRETSEN, JELL, AUNG, PFAFFENRITTER, TROTTER & WITHNALL, Pl. 13, Fig. 17.
1999 *Ozarkodina remscheidensis remscheidensis* (ZIEGLER) – VIIRA, Pl. 3, Fig. 13.
2003 *Ozarkodina remscheidensis remscheidensis* (ZIEGLER) – MAWSON, TALENT, MOLLOY & SIMPSON, p. 90; Pl. 2, Figs. 18, 19 [cum syn.].
2004 *Zieglerodina remscheidensis* (ZIEGLER) – MURPHY, VALENZUELA-RÍOS & CARLS, p. 13; Fig. 3.24.
2005 *Ozarkodina remscheidensis remscheidensis* (ZIEGLER) – TROTTER & TALENT, p. 42; Pl. 18, Fig. 4.
2006 *Ozarkodina remscheidensis remscheidensis* (ZIEGLER) – MATHIESON, p. 56; Pl. 19, Fig. S.

Description: Elements have a long, evenly curved posterior process joining the shorter anterior extremity. The blade covers irregular alternating denticles; these are discrete with pointed tips and elliptical cross-section. The cusp and larger denticles are reclined, pointing slightly to the inner side. No ledge is evident at the base of the denticles. The blade is undulating. The basal cavity is small passing into adpressed basal grooves.

M element (Pl. 12, Figs. 5, 6)

1979 *Ozarkodina remscheidensis remscheidensis* (ZIEGLER) – LANE & ORMISTON, p. 57; Pl. 1, Fig. 17.
1980 *Ozarkodina remscheidensis remscheidensis* (ZIEGLER) – SERPAGLI & MASTANDREA, p. 39; Pl. 1, Fig. 1.
1985a *Ozarkodina remscheidensis remscheidensis* (ZIEGLER) – MASTANDREA, p. 252; Pl. 1, Fig. 4.
1986 *Ozarkodina remscheidensis remscheidensis* (ZIEGLER) – MAWSON, p. 49; Pl. 6, Figs. 12, 13.
1989 *Ozarkodina remscheidensis remscheidensis* (ZIEGLER) – SORENTINO, p. 93; Pl. 3, Fig. 19.
1989 *Ozarkodina remscheidensis remscheidensis* (ZIEGLER) – WILSON, p. 138; Pl. 11, Figs. 11, 12.
1990 *Ozarkodina remscheidensis remscheidensis* (ZIEGLER) – UYENO, p. 93; Pl. 5, Fig. 37; Pl. 16, Fig. 38?; Pl. 17, Fig. 34 [cum syn.].
1995 *Ozarkodina remscheidensis remscheidensis* ZIEGLER – COLQUHOUN, Pl. 3, Fig. 7.
1995 *Ozarkodina remscheidensis remscheidensis* (ZIEGLER) – SLOAN, TALENT, MAWSON, SIMPSON, BROCK, ENGELBRETSEN, JELL, AUNG, PFAFFENRITTER, TROTTER & WITHNALL, Pl. 13, Fig. 19.
1999 *Ozarkodina remscheidensis remscheidensis* (ZIEGLER) – TALENT & MAWSON, Pl. 12, Fig. 15.
1999 *Ozarkodina remscheidensis remscheidensis* (ZIEGLER) – VIIRA, Pl. 3, Fig. 9?
2001 *Ozarkodina remscheidensis remscheidensis* (ZIEGLER) – PACKHAM, PERCIVAL, RICKARDS & WRIGHT, Fig. 2G.
2003 *Ozarkodina remscheidensis remscheidensis* (ZIEGLER) – MAWSON, TALENT, MOLLOY & SIMPSON, p. 90; Pl. 2, Fig. 15 [cum syn.].
2004 *Zieglerodina remscheidensis* (ZIEGLER) – MURPHY, VALENZUELA-RÍOS & CARLS, p. 13; Figs. 3.14–3.16, 3.19.
2005 *Ozarkodina remscheidensis remscheidensis* (ZIEGLER) – CORRADINI, SIMONETTO, SERVENTI, RIGO & CALLIGARIS, Fig. 5d.
2006 *Ozarkodina remscheidensis remscheidensis* (ZIEGLER) – MATHIESON, p. 56; Pl. 19, Fig. T.

Description: Elements possess a very high cusp with a pointed, slightly inwardly-directed tip. The anterior blade is rather low with 3 denticles decreasing distally. The posterior blade is steeply descending and usually has no prominent ledge developed. It bears more than 10 denticles alternating in size, with the distal part of the process often broken. Denticles are closely spaced with their tips erect. The lower margin of the processes includes an angle between 90 and 100 degrees. The basal cavity is flattened on the outer side, possessing a well-rounded margin on the inner side. The posterior basal groove is narrowly open. The anterior groove is open proximally, becoming adpressed in many specimens.

Pa element (Pl. 17, Figs. 6–13; Pl. 18, Fig. 1)

1960 *Spathognathodus remscheidensis* n. sp. ZIEGLER, p. 194; Pl. 13, Figs. 1, 2, 4, 5, 7, 8, 10, 14?
1960 *Spathognathodus* cf. *frankenwaldensis* BISCHOFF & SANNEMANN – ZIEGLER, Pl. 13, Fig. 13.
non 1966 *Spathognathodus remscheidensis* ZIEGLER – CLARK & ETHINGTON, p. 686; Pl. 84, Figs. 12, 14.
1968 *Spathognathodus steinhornensis remscheidensis* ZIEGLER – SCHULZE, p. 228; Pl. 17, Fig. 12.
non 1969 *Spathognathodus steinhornensis remscheidensis* ZIEGLER – CARLS & GANDL, p. 197; Pl. 19, Fig. 2.
1969 *Spathognathodus remscheidensis* ZIEGLER – KLAPPER, p. 21; Pl. 4, Figs. 1–3?, 4–12.
1969b *Spathognathodus steinhornensis remscheidensis* ZIEGLER – PÖLSLER, p. 433; Pl. 2, Figs. 15–20.
1971 *Spathognathodus steinhornensis remscheidensis* ZIEGLER – BULTYNCK, p. 11; Text-Figs. 4–10, 11.
non 1975 *Ozarkodina remscheidensis* (ZIEGLER) – CARLS, Pl. 2, Figs. 16–18.
1975 *Ozarkodina remscheidensis remscheidensis* (ZIEGLER) – KLAPPER & MURPHY, Pl. 7, Figs. 22, 25–30.
1979 *Ozarkodina remscheidensis remscheidensis* (ZIEGLER) – LANE & ORMISTON, p. 57; Pl. 1, Figs. 3–5, 8, 15, 18, 34.
1980 *Ozarkodina r. remscheidensis* (ZIEGLER) – CHLUPÁČ, KŘÍŽ & SCHÖNLAUB, Pl. 18, Figs. 11, 14–26; Pl. 19, Figs. 7, 13, 14, 18–21; Pl. 20, Figs. 1–3.
1980 *Ozarkodina remscheidensis* (ZIEGLER) – PICKETT, Fig. 13.D–F, non Fig. 13.G.
1980b *Ozarkodina r. remscheidensis* (ZIEGLER) – SCHÖNLAUB, Pl. 1, Figs. 1, 2?, 3?, 8–10, 12, 13, 15, 16, 18, 20, 21; Pl. 2, Figs. 1–3; Pl. 3, Figs. 14, 17, 18?, 20?, 21; Pl. 4, Fig. 2; Pl. 6, Figs. 4, 6, 7, 9; Pl. 7, Figs. 2, 7, 29; non Pl. 6, Fig. 11.
1980 *Ozarkodina remscheidensis remscheidensis* (ZIEGLER) – SERPAGLI & MASTANDREA, p. 39; Pl. 1, Figs. 7, 8, 12.
1983 *Ozarkodina remscheidensis remscheidensis* (ZIEGLER) – MURPHY & MATTI, Pl. 2, Figs. 4, 5, 6?
1985 *Ozarkodina remscheidensis remscheidensis* (ZIEGLER) – CHLUPÁČ, LUKEŠ, PARIS & SCHÖNLAUB, Pl. 2, Fig. 30.
1985a *Ozarkodina remscheidensis remscheidensis* (ZIEGLER) – MASTANDREA, p. 252; Pl. 1, Figs. 1–3.
1985b *Ozarkodina r. remscheidensis* (ZIEGLER) – MASTANDREA, Pl. 1, Fig. 1.
1985b *Ozarkodina remscheidensis remscheidensis* (ZIEGLER) – SCHÖNLAUB, Pl. 1, Figs. 1–3, 8–10, 12, 13, 15, 16, 18, 20, 21; Pl. 2, Figs. 1–3.
1986 *Ozarkodina remscheidensis remscheidensis* (ZIEGLER) – MAWSON, p. 49; Pl. 6, Figs. 1–5, 7, 8, non Fig. 6.
non 1989 *Ozarkodina s. remscheidensis* (ZIEGLER) – JEPPSSON, p. 28; Pl. 2, Figs. 6–11.
1989 *Ozarkodina remscheidensis remscheidensis* (ZIEGLER) – SORENTINO, p. 93; Pl. 3, Figs. 3–9, 12, 13, non Figs. 1, 2.
1989 *Ozarkodina remscheidensis remscheidensis* (ZIEGLER) – WILSON, p. 138; Pl. 11, Figs. 8–10.
1990 *Ozarkodina remscheidensis remscheidensis* (ZIEGLER) – UYENO, p. 93; Pl. 4, Figs. 4–6; Pl. 5, Fig. 30, non Figs. 1–3, 6, 7; Pl. 6, Fig. 11; Pl. 13, Figs. 11, 12, 20; Pl. 15, Figs. 27, 28, non Figs. 32–34; Pl. 16, Figs. 34, 35; Pl. 17, Figs. 10?, 32 [cum syn.].
1991 *Ozarkodina remscheidensis remscheidensis* (ZIEGLER) – UYENO, Pl. 1, Fig. 13.
1992 *Ozarkodina remscheidensis remscheidensis* (ZIEGLER) – BARDASHEV & ZIEGLER, Pl. 1, Figs. 5, 6.
1994 *Ozarkodina remscheidensis remscheidensis* (ZIEGLER) – MAWSON & TALENT, Fig. 13. N, O.
1995 *Ozarkodina remscheidensis remscheidensis* (ZIEGLER) – BARRICK & NOBLE, Figs. 6.9, 6.12, 6.15, 6.16.
1995 *Ozarkodina remscheidensis remscheidensis* ZIEGLER – COLQUHOUN, Pl. 1, Figs. 9, 10.
1995 *Ozarkodina remscheidensis remscheidensis* (ZIEGLER) – SLOAN, TALENT, MAWSON, SIMPSON, BROCK, ENGELBRETSEN, JELL, AUNG, PFAFFENRITTER, TROTTER & WITHNALL, Pl. 12, Figs. 9, 10; Pl. 13, Fig. 16.
1997 *Ozarkodina remscheidensis remscheidensis* (ZIEGLER) – MILLER & ALDRIDGE, p. 46; Pl. 1, Figs. 21, 24; Text-Fig. 2.
1998a *Ozarkodina rem. remscheidensis* (ZIEGLER) – CORRADINI, FERRETTI & SERPAGLI, Pl. 2.3.1, Fig. 4.
1998b *Ozarkodina remscheidensis remscheidensis* (ZIEGLER) – CORRADINI, FERRETTI & SERPAGLI, Pl. 3.3.1, Fig. 8?
1998 *Ozarkodina remscheidensis remscheidensis* ZIEGLER – SERPAGLI, CORRADINI & FERRETTI, Pl. 1.2.2, Fig. 6.
1999 *Ozarkodina remscheidensis remscheidensis* (ZIEGLER) – BENFRIKA, p. 315; Pl. 1, Fig. 6?
1999 *Ozarkodina remscheidensis remscheidensis* (ZIEGLER) – TALENT & MAWSON, Pl. 5, Figs. 13–18; Pl. 7, Fig. 12; Pl. 8, Fig. 1.
1999 *Ozarkodina remscheidensis remscheidensis* (ZIEGLER) – VIIRA, Pl. 3, Figs. 5–7.
2001 *Ozarkodina remscheidensis remscheidensis* (ZIEGLER) – PACKHAM, PERCIVAL, RICKARDS & WRIGHT, Fig. 2A, E.
2003 *Ozarkodina remscheidensis remscheidensis* (ZIEGLER) – FARRELL, Pl. 8, Figs. 1–18 [cum syn.].
2003 *Ozarkodina remscheidensis remscheidensis* (ZIEGLER) – MAWSON, TALENT, MOLLOY & SIMPSON, p. 90; Pl. 2, Figs. 1–11; Pl. 4, Figs. 17, 18 [cum syn.].
2004 *Ozarkodina remscheidensis remscheidensis* (ZIEGLER) – FARRELL, p. 974; Pl. 10, Figs. 1–9.
2004 *Zieglerodina remscheidensis* (ZIEGLER) – MURPHY, VALENZUELA-RÍOS & CARLS, p. 13; Figs. 3.1–3.8.
2005 *Ozarkodina remscheidensis remscheidensis* (ZIEGLER) – CORRADINI, SIMONETTO, SERVENTI, RIGO & CALLIGARIS, Fig. 5b, c.
2005 *Ozarkodina remscheidensis remscheidensis* (ZIEGLER) – TROTTER & TALENT, p. 42; Pl. 18, Figs. 1, 3.
2006 *Ozarkodina remscheidensis remscheidensis* (ZIEGLER) – MATHIESON, p. 56; Pl. 19, Figs. A–N.

Description: The axis of the blade is rather straight or slightly arched. There is no ledge at the base of the denticles, and no or only a very weak pinch zone. The blade of the anterior process seems a little higher compared to the posterior one. The distal part of the anterior process (cockscomb) bears none or one small denticle and one or two markedly higher denticles followed by two to five denticles of irregular size. The cusp is very high and broad at its base and usually as large or even larger than denticles of the cockscomb. Denticles (four to five in number) of the posterior process are variable in size, similar to those between the cockscomb and cusp of the anterior process. They are nearly triangular, fused at the base, with an elliptical cross-section. The basal platform is rounded to heart-shaped and covers about one-quarter of the length of the blade, with a position posterior to the mid-length. The anterior margin of the platform lobes start to expand slightly anterior to or at the middle of the blade. Lobes seem nearly symmetrical in upper view, but in many cases the outer margin of the plaform is broken so that the distinct shape can only be inferred. Both lobes are unornamented. The basal cavity forms open with basal grooves extending to both margins distally. The lower margin is stepped or somewhat sigmoidal in many specimens. Elements possessing a straight lower profile are rare.

Remarks: Compared to other spathognathodontids the Pa elements of *Ozarkodina remscheidensis* have distinctively rounded to heart-shaped, unornamented platform lobes and an extremely irregular upper profile.

Pb element

1979 *Ozarkodina remscheidensis remscheidensis* (ZIEGLER) – LANE & ORMISTON, p. 57; Pl. 1, Fig. 43.
1980 *Ozarkodina remscheidensis* (ZIEGLER) – PICKETT, Fig. 13.B.
1980 *Ozarkodina remscheidensis remscheidensis* (ZIEGLER) – SERPAGLI & MASTANDREA, p. 39; Pl. 1, Fig. 9.
1985a *Ozarkodina remscheidensis remscheidensis* (ZIEGLER) – MASTANDREA, p. 252; Pl. 1, Fig. 5.
1986 *Ozarkodina remscheidensis remscheidensis* (ZIEGLER) – MAWSON, p. 49; Pl. 6, Figs. 9–11.
1989 *Ozarkodina remscheidensis remscheidensis* (ZIEGLER) – SORENTINO, p. 93; Pl. 3, Fig. 18.
1989 *Ozarkodina remscheidensis remscheidensis* (ZIEGLER) – WILSON, p. 138; Pl. 11, Fig. 13.
1990 *Ozarkodina remscheidensis remscheidensis* (ZIEGLER) – UYENO, p. 93; Pl. 5, Figs. 8?, 33; Pl. 16, Fig. 36?; Pl. 17, Fig. 33? [cum syn.].
1995 *Ozarkodina remscheidensis remscheidensis* (ZIEGLER) – COLQUHOUN, Pl. 3, Fig. 1.
1995 *Ozarkodina remscheidensis remscheidensis* (ZIEGLER) – SLOAN, TALENT, MAWSON, SIMPSON, BROCK, ENGELBRETSEN, JELL, AUNG, PFAFFENRITTER, TROTTER & WITHNALL, Pl. 13, Fig. 18.
1999 *Ozarkodina remscheidensis remscheidensis* (ZIEGLER) – VIIRA, Pl. 3, Fig. 8.
2003 *Ozarkodina remscheidensis remscheidensis* (ZIEGLER) – MAWSON, TALENT, MOLLOY & SIMPSON, p. 90; Pl. 2, Figs. 12–14 [cum syn.].
2004 *Zieglerodina remscheidensis* (ZIEGLER) – MURPHY, VALENZUELA-RÍOS & CARLS, p. 13; Figs. 3.9–3.11.
2005 *Ozarkodina remscheidensis remscheidensis* (ZIEGLER) – CORRADINI, SIMONETTO, SERVENTI, RIGO & CALLIGARIS, Fig. 5a.
2005 *Ozarkodina remscheidensis remscheidensis* (ZIEGLER) – TROTTER & TALENT, p. 42; Pl. 18, Figs. 5, 6.
2006 *Ozarkodina remscheidensis remscheidensis* (ZIEGLER) – MATHIESON, p. 56; Pl. 19, Figs. O–Q.

Description: The blade is rather low compared to the denticles of the anterior process; these increase in height progressively with their base remaining low, unelevated. Denticles of the posterior process are needle-like too, but much smaller and more uniform in height and shape. The lower margin is curved with anterior and posterior tips pointing downward. The basal cavity has a nearly symmetrical outline with greatest width in the anterior one-third, tapering posteriorly. The basal grooves are narrowly open becoming adpressed towards the distal margins. The lower part of the blade is pinched.

Remarks: Most elements presented in other papers are illustrated in lateral view only, so that the outline of the basal cavity and the shape of the basal grooves cannot be inferred. The Pb element figured by ZIEGLER, 1960 (Plate 15, Fig. 15) shows a rather high, slender cusp and proximal denticles in front of the cusp which are almost as high as the cusp. MURPHY et al. (2004) classified Pb elements of *'Zieglerodina'* (= *Ozarkodina remscheidensis*) by the following criteria: angulate pectiniform element; equally wide anterior denticles increasing in height progressively posteriorly almost to height of cusp; cusp wide and high; denticles of the posterior process shorter and more even in height.

Ozarkodina remscheidensis repetitor (CARLS & GANDL, 1969)

Pl. 19, Figs. 7, 9

Material: 2 specimens.

Pa element (Pl. 19, Figs. 7, 9)

1969 *Spathognathodus steinhornensis repetitor* n. ssp. CARLS & GANDL, p. 198; Pl. 19, Fig. 3.
1969 *Spathognathodus steinhornensis repetitor* CARLS & GANDL – CARLS, p. 340; Pl. 2, Figs. 21–23; Pl. 3, Figs. 1–6, Fig. 4?
1971 *Spathognathodus steinhornensis repetitor* CARLS & GANDL – BULTYNCK, p. 18; Pl. 3, Figs. 1–24; Pl. 4, Figs. 1–5; Text-Figs. 12–14, 15–18.
1973a *Ozarkodina steinhornensis repetitor* (CARLS & GANDL) – KLAPPER, LINDSTRÖM, SWEET & ZIEGLER, p. 245; Pl. 2, Fig. 6 [= specimen Pl. 19, Fig. 3; CARLS & GANDL, 1969].
1980 *Ozarkodina steinhornensis repetitor* (CARLS & GANDL) – KLAPPER & JOHNSON, Pl. 1, Fig. 1.
1985a *Ozarkodina steinhornensis repetitor* (CARLS & GANDL) – MASTANDREA, p. 254; Pl. 1, Figs. 13, 18.
1992 *Ozarkodina steinhornensis repetitor* (CARLS & GANDL) – BARDASHEV & ZIEGLER, Pl. 1, Figs. 8–10.
1994 *Ozarkodina steinhornensis repetitor* (CARLS & GANDL) – MAWSON & TALENT, Fig. 13. I.
?1995 *Pandorinellina steinhornensis repetitor* (CARLS & GANDL) – BONCHEVA, Pl. 1, Fig. 5.
1995 *Ozarkodina remscheidensis repetitor* CARLS & GANDL – COLQUHOUN, Pl. 1, Fig. 13.
1999 *Ozarkodina steinhornensis repetitor* (CARLS & GANDL) – BENFRIKA, p. 316; Pl. 1, Fig. 11.
1999 *Ozarkodina remscheidensis repetitor* (CARLS & GANDL) – TALENT & MAWSON, Pl. 7, Figs. 11, 17, 18.
2003 *Ozarkodina remscheidensis repetitor* (CARLS & GANDL) – FARRELL, p. 138; Pl. 9, Fig. 4–7.
2005 *Ozarkodina remscheidensis repetitor* (CARLS & GANDL) – TROTTER & TALENT, p. 42; Pl. 18, Fig. 21.

Description: Two different representatives of Pa elements were obtained. Both types have a rather straight axis, a very compressed blade and a narrow symmetrical basal platform in upper view. The platform is subcentral, posterior to mid-length. Denticles on either blade show an almost even upper profile. Elements differ slightly in development of the lower margin, the degree of inclination of the denticles, and the outline of the platform. One type (Plate 19, Fig. 7) bears about 10 or more (posteriormost part broken) pointed denticles, inclined posteriorly (five denticles have only the basal portion preserved). The lower margin of the posterior blade is straight and neither stepped nor sigmoidal. The anterior lower margin seems convex, possibly resulting from breakage of the anteriormost lower part of the process. The margin of the symmetrical platform lobes tapers gently and is curved towards either side, with the greatest width in the anterior one-third of the platform. The second type (Plate 19, Fig. 9) is covered by 9 less strongly inclined denticles. Denticles are of uniform height, except a somewhat smaller one on either side of the cusp. The platform is symmetrical and less wide. The lower margin of each process is inclined and characterised by adpressed basal grooves.

Remarks: One of the illustrated specimens (Plate 19, Fig. 7) seems identical to that obtained by BENFRIKA (1999). It resembles the αr morph according to the proposed discrimination of BULTYNCK (1971). The second Pa element is close to the γr morph of BULTYNCK, 1971 (especially: Plate 3, Fig. 10). *Ozarkodina remscheidensis repetitor* differs in a regular, more subtly designed Pa element and in development of a symmetrical outline of the platform compared to *Ozarkodina remscheidensis remscheidensis* and *Ozarkodina remscheidensis eosteinhornensis*, respectively. FARRELL (2003) suggested a maximum range from the *woschmidti* to the *kindlei* Zones by referring to several authors.

Ozarkodina cf. *O. remscheidensis* ssp.

Pl. 12, Fig. 11; Pl. 15, Figs. 1, 2, 5; Pl. 18, Figs. 4, 7–9

Material: 7 specimens.

Sa element (Pl. 12, Fig. 11)

cf. 2004 *Zieglerodina remscheidensis* (ZIEGLER) – MURPHY, VALENZUELA-RÍOS & CARLS, p. 13; Fig. 3.45.

Description: Denticles are closely spaced with needle-like tips showing a subcircular to elliptical cross-section. A few small denticles are developed proximally to the cusp, and start to alternate in size towards the distal margin of either lateral process. Both processes include an angle of about 125 degrees.The basal cavity is rather small, not raised, and forms only a short posterior extension.

Remarks: The preserved part of the obtained specimen has great affinity to that figured by MURPHY et al. (2004) from the Lag Vas 6 glacial erratic boulder (northern Germany). As this type differs markedly in the kind of denticulation and the angle of the processes compared to the Sa elements assigned to *Ozarkodina remscheidensis remscheidensis*, it possibly represents another (sub?) species.

Pa element (Pl. 18, Figs. 4, 7–9)

Description: Elements are rather large and robust. The axis is straight to arched. Denticles are discrete, aligned at the base with free tips and vary in height along both processes. The anterior process usually bears 7 denticles; an initial, very small denticle, is followed by three to four larger denticles that show only slight variations in size. Close to the wide and rather high cusp, two or three small denticles occur on either side. The remaining denticles of the posterior process vary in height, but are not larger than the anterior high denticles or the cusp. The denticles and the cusp have a lens-shaped cross-section and seem to be pointed, but usually the tip is broken. Some denticles are finely striate. The basal platform is symmetrical, rounded to somewhat heart-shaped and lacks ornament. Some elements have platform lobes that tend to be asymmetrical and slightly wider than long. The platform is located in a central to slightly posterior position. The lower margin is straight, stepped to gently inclined. In the lower half to one-third of the blade, a weak pinched zone is developed in some specimens. The basal cavity is unconstricted, passing into narrowly open basal grooves.

Remarks: Obtained elements are similar to *Ozarkodina remscheidensis remscheidensis*, but much too broken, even for proper assignment at species-level.

Pb element (Pl. 15, Figs. 1, 2, 5)

cf. 1989 *Ozarkodina s. eosteinhornensis* (WALLISER) sensu JEPPSSON 1975 – JEPPSSON, p. 28; Pl. 3, Fig. 10.
cf. 1997 *Ozarkodina remscheidensis eosteinhornensis* (WALLISER) – MILLER & ALDRIDGE, p. 45; Figs. 5a, b.
cf. 2003 *Ozarkodina remscheidensis eosteinhornensis* (WALLISER) – MAWSON, TALENT, MOLLOY & SIMPSON, p. 89; Pl. 2, Figs. 20, 21.
cf. 2004 *W eosteinhornensis* (WALLISER) – MURPHY, VALENZUELA-RÍOS & CARLS, p. 16; Figs. 3.26–3.28.

Description: Specimens have a rather broad cusp. A certain angularity close to mid-height of the cusp and slightly above the alignment of the anterior and posterior margin to adjacent denticles is observed in lateral view. The anterior margin (aligned to denticle) and the free upper anterior margin of the cusp includes an angle of 143 to 145 degrees. The anterior margin of the remaining free part of the cusp is inclined and forms a line with the upper margin of the anterior process. The anteriormost denticles are somewhat wider than the proximal 2 to 3 denticles. The anterior blade of *Ozarkodina remscheidensis eosteinhornensis* seems shorter compared to that of *Ozarkodina remscheidensis remscheidensis*, and is little higher proximally to the cusp. The basal cavity has a nearly symmetrical outline with greatest width in the anterior one-third, tapering posteriorly. The basal grooves are narrowly open, becoming adpressed towards the distal margins. The lower part of the blade is pinched.

Remarks: These Pb elements from the Seewarte section are very close to *Ozarkodina remscheidensis eosteinhornensis* (*'W eosteinhornensis'* in MURPHY et al. [2004, Figs. 3.26–3.28]). Since no corresponding Pa elements were found within the same samples, specimens are not assigned to *Ozarkodina r. eosteinhornensis*.

Ozarkodina wurmi (BISCHOFF & SANNEMANN, 1958)

Pl. 17, Fig. 4

Material: 4 specimens.

Pa element (Pl. 17, Fig. 4)

1986 *Ozarkodina excavata* (BRANSON & MEHL) – MURPHY & CEBECIOĞLU, Figs. 1.8, 1.9.
1994a *Ozarkodina wurmi* BISCHOFF & SANNEMANN – VALENZUELA-RÍOS, p. 71; lam. 4, Fig. 1.
2004 *Wurmiella wurmi* (BISCHOFF & SANNEMANN) – ROOPNARINE, MURPHY & BUENING, p. 3; Figs. 1B?, 2.

Description: Specimens are rather long, possessing about 20 denticles. The denticles vary in size, becoming a little larger towards the distal ends. The cusp, covering a position above the basal cavity, is underdeveloped and therefore similar in size to the denticles. The blade axis is nearly straight with a slight twisting of the distal parts of the blade. A ledge is developed on either side (weak on the outer and little more pronounced on the inner side). The lower margin is biconcave. The basal cavity is small with a position posterior mid-length. The inner platform lobe is more expanded and slightly inflated. The basal cavity is moderately deep with the basal grooves becoming adpressed distally.

Remarks: Following the revised diagnosis for *Ozarkodina wurmi* (*'Wurmiella wurmi'* in MURPHY et al. [2004, 11]), a convexo-concave or biconcave lower margin represents one of the most reliable features distinguishing *Ozarkodina wurmi* from *Ozarkodina excavata excavata* and *Ozarkodina excavata tuma*.

Genus: *Pandorinellina* MÜLLER & MÜLLER, 1957

Type species: *Pandorina insita* STAUFFER, 1940.

General Remarks: *Pandorinellina* is separated from *Ozarkodina* by its diplododellan Sa element with a denticulate posterior process as discriminative feature of this genus. The apparatus of *Ozarkodina* is reconstructed with a trichonodellan Sa element (only lateral processes are present; they lack the distinctive denticulate posterior process). Varieties of both apparatuses are demonstrated by KLAPPER & PHILIP (1971). The relation of *Pandorinellina* to *Ozarkodina* was discussed further by BULTYNCK (1971), FÅHRAEUS (1974), BONCHEVA (1995), FARRELL (2003), KLAPPER et al. (1973b) and MURPHY et al. (2004). In FARRELL (2003), three morphological groups (Optima, Exigua and Steinhornensis groups) are discriminated within *Pandorinellina* by the outline of the anterior denticle-set of the assumed Pa elements (compare Appendix 4).

Representatives of the Optima group have an arcuate anterior denticle-set with a centred vertex. The group includes the species and subspecies *Pandorinellina ebzeryi, Pandorinellina optima optima, Pandorinellina o. postoptima* and *Pandorinellina o. postexcelsa*. The lineage of *Pand. optima* suggested by FARRELL (2003) is followed here. According to the development of the base in the Optima group and the evolution of *Pand. o. postexcelsa* from *Pand. o. optima*, a scenario was suggested by BARDASHEV et al. (2002). In their article subspecies of *Pand. optima* were assigned to a new genus *Pseudogondwania*, and a relation between the lineages of *Pandorinellina optima* and certain species of *Eognathodus* (also assigned to *Pseudogondwania*) was proposed.

Species of the Exigua group possess an anterior denticle-set increasing in height with the posteriormost denticle highest. This group includes about 11 different types with *Pandorinellina exigua exigua* and *Pand. e. philipi* remaining as the mostly quoted representatives in papers dealing with Lower Devonian conodonts.

Contrary to the features of the above listed groups, Pa elements assigned to the Steinhornensis group lack any raised denticle-sets. Generally they show a bowed axis of the blade bearing numerous subequal denticles (e.g: *Pandorinellina miae, Pand. steinhornensis praeoptima* and *Pand. st. steinhornensis*).

Pandorinellina cf. *Pand. ebzeryi* FARRELL, 2003

Pl. 20, Figs. 3, 6

Material: 2 specimens.

Pa element (Pl. 20, Figs. 3, 6)

aff. 1980 *Pandorinellina* cf. *optima* (MOSKALENKO) – CHLUPÁČ, KŘÍŽ & SCHÖNLAUB, Pl. 20, Figs. 5–8.

cf. 2003 *Pandorinellina ebzeryi* n. sp. FARRELL, p. 143; Pl. 10, Figs. 1–8; Text-Fig. 7.

Description: The figured Pa elements bear a raised anterior denticle-set, strongly fused at the base and covering about a quarter of the entire length. Due to breakage, the discriminative outline of the denticle-set, whether arcuate or ascending, cannot be identified with accuracy. Nevertheless the height of anterior denticles could possibly be estimated from the corresponding size of the oval to lenticular cross-section. One Pa element (Plate 20, Fig. 3) shows that the cross-section of the middle denticle is more elongated than that of the preserved one with the anteriormost denticle shortest. The longer lenticular cross-section of the second anterior denticle accords with a generally larger size of the denticle compared to the preserved one. The second Pa element (Plate 20, Fig. 6) differs in bearing 4 anterior denticles with the second and third denticle notably enlarged. The anteriormost denticle is small with a broken tip. The fourth denticle is broken too, but the posterior margin of the third and highest denticle shows, that the fusion between them reaches almost as high as that between the second and third denticle. In lateral view the fourth denticle is aligned with the one in front of it, and having a definite space between it and the one posterior to it. It is concluded from this that the unbroken anterior denticle-set was arcuate. The cusp is enlarged in both elements. Mid-blade denticles on either side of the cusp are relatively small. Denticles of the posterior carina are arcuate in upper profile due to the decreasing size of denticles towards the posterior margin. The axis of the blade is nearly straight. The anterior and posterior lower margin is steeply inclined. The anterior lower margin meets the anterior margin including an angle between 112–120 degrees. Compared to the anterior one, the posterior lower margin increases less steeply with a nearly straight outline in lateral view. The rounded basal platform is asymmetrical with one of the lobes wider. The basal cavity is central to slightly posteriorly located. The anterior and posterior margins of each lobe taper to either side along the blade as shallow, open grooves.

Remarks: The specimens might look like Pa elements of *Ozarkodina remscheidensis remscheidensis* at first glance (especially that on Plate 20, Fig. 6). But in no Pa element of *O. r. remscheidensis* observed, the anterior lower margin was that inclined as it is in material of FARRELL (2003) or the present one.

Apart from the outline of the anterior denticle-set – which would definitively indicate assignment to the Optima group – all other features accord with *Pandorinellina ebzeryi*. Even if the figured Pa elements were to possess an ascending anterior denticle-set, they would come close to *Pandorinellina exigua philipi* but would still differ in the profile of the posterior lower margin, the outline of platform lobes, and the shape of denticles. At its type locality (The Gap, New South Wales) *Pand. ebzeryi* ranges from the *pesavis* to early *sulcatus* Zones (FARRELL, 2003). The present specimens are from the late *delta* Zone.

Pandorinellina miae (BULTYNCK, 1971)

Pl. 20, Fig. 7

Material: 1 specimen.

Pa element (Pl. 20, Fig. 7)

1971 *Spathognathodus steinhornensis miae* n. subsp. BULTYNCK, p. 25; Pl. 4, Figs. 13, 14; Pl. 5, Figs. 1–14; Text-Figs. 19–21, 22.

1979 *Pandorinellina steinhornensis miae* (BULTYNCK) – LANE & ORMISTON, p. 59; Pl. 5, Figs. 15, 16, 23.

1980 *Ozarkodina steinhornensis miae* (BULTYNCK) – BULTYNCK & HOLLARD, Pl. 2, Figs. 3, 4.

1980 *Pandorinellina st. miae* (BULTYNCK) – CHLUPÁČ, KŘÍŽ & SCHÖNLAUB, Pl. 21, Figs. 7, 19, 20, 22; Pl. 23, Figs. 11, 12; Pl. 24, Figs. 4, 13, 16.

1983 *Pandorinellina steinhornensis miae* (BULTYNCK) – WANG & ZIEGLER, Pl. 4, Fig. 13.

1985b *Pandorinellina steinhornensis miae* (BULTYNCK) – SCHÖNLAUB, Pl. 3, Figs. 11–12.

1985b *Pandorinellina steinhornensis miae* (BULTYNCK) – MASTANDREA, p. 264; Pl. 1, Figs. 2, 3.

1986 *Pandorinellina steinhornensis miae* (BULTYNCK) – BARCA, GNOLI, OLIVIERI & SERPAGLI, Pl. 30, Figs. 7–9.

1989 *Ozarkodina steinhornensis miae* (BULTYNCK) – BULTYNCK, Pl. 6, Figs. 10–11.

1990 *Pandorinellina steinhornensis miae* (BULTYNCK) – GARCIA-ALCALDE, ARBIZU, GARZÍA LÓPEZ, LEYVA, MONTESINOS, SOTO & TRUYOLS-MASSONI, Figs. 10.5, 10.6.

1990 *Pandorinellina steinhornensis miae* (BULTYNCK) – GARZÍA LÓPEZ, JULIVERT, SOLDEVILA, TRUYOLS-MASSONI & ZAMARRENO, Pl. 1, Figs. 21–23.

1991 *Pandorinellina steinhornensis miae* (BULTYNCK) – UYENO, Pl. 2, Fig. 17.

1992 *Pandorinellina miae* (BULTYNCK) – BARDASHEV & ZIEGLER, Pl. 1, Figs. 41, 47.

1994 *Pandorinellina steinhornensis miae* (BULTYNCK) – MAWSON & TALENT, p. 55; Fig. 11. A–G.

1995 *Pandorinellina steinhornensis miae* (BULTYNCK) – KALVODA, p. 38; Pl. 2, Figs. 3, 8.

1995 *Pandorinellina steinhornensis miae* (BULTYNCK) – FUREY-GREIG, Pl. 1, Fig. 18?

1995 *Pandorinellina steinhornensis miae* (BULTYNCK) – COLQUHOUN, Pl. 2, Figs. 7, 9.

1999 *Pandorinellina steinhornensis miae* (BULTYNCK) – BENFRIKA, p. 316; Pl. 1, Fig. 19?

?1999 *Pandorinellina steinhornensis miae* (BULTYNCK) – TALENT & MAWSON, Pl. 5, Figs. 11, 12; Pl. 12, Figs. 11–13.

2004 *Pandorinellina miae* (BULTYNCK) – FARRELL, p. 976; Pl. 10, Figs. 10–13.

2004a *Ozarkodina steinhornensis miae* (BULTYNCK) – SLAVÍK, Pl. 1, Figs. 11.7–11.11.

Description: The anterior process of the figured element has an arched to gently twisted axis. The blade of the remaining process is rather low in lateral view and bears 9 denticles (with the anteriormost one broken). The posterior blade is broken, so no information about the curvature of the axis can be given. The denticles are subequal in size, closely spaced with blunt tips, and lenticular in cross-section. The cusp is a little wider at its base and seems a little larger than the denticles. The platform is slightly asymmetrical with rounded to heart-shaped platform lobes. Due to the rather long anterior process (compared with the size of the denticles), the platform seems to occupy a position posterior to the centre of the blade. Both lobes are unornamented. The lower margin of the anterior process is broken distally but seems to be gently curved.

Remarks: Usually the posterior blade is much shorter than the anterior one and often strongly arched in upper view. The upper profile of the posterior process can be straight to curving gently downwards resulting in slightly smaller denticles distally. The illustrated element is almost identical with the specimens assigned to the beta morph by BULTYNCK (1971).

Pandorinellina optima optima (MOSKALENKO, 1966)

Pl. 20, Fig. 2

Material: 2 specimens.

Pa element (Pl. 20, Fig. 2)

1969 *Spathognathodus optimus* MOSKALENKO – KLAPPER, p. 20; Pl. 4, Figs. 13–24, 26–29, non Fig. 25.
1971 *Spathognathodus optimus* MOSKALENKO – FÅHRAEUS, p. 679; Pl. 77, Figs. 15, 16.
non 1989 *Pandorinellina optima* (MOSKALENKO) – SORENTINO, p. 94; Pl. 4, Figs. 8–16.
1991 *Pandorinellina optima* (MOSKALENKO) – UYENO, Pl. 1, Figs. 6, 9, 10.
1992 *Pandorinellina optima* (MOSKALENKO) – BARDASHEV & ZIEGLER, Pl. 1, Figs. 19–21.
1994 *Pandorinellina optima* (MOSKALENKO) – MAWSON & TALENT, Fig. 13. K, L.
non 1999 *Pandorinellina optima* (MOSKALENKO) – TALENT & MAWSON, Pl. 7, Figs. 7, 8.
2003 *Pandorinellina optima optima* (MOSKALENKO) – FARRELL, p. 140; Fig. 7.

Description: The figured element has fused, needle-like denticles with free tips. The cross-section of the denticles is subcircular to elliptical. The anterior denticle-set has markedly larger denticles arcuate in upper profile with the third one being highest. It extends for a third of the blade-length. The mid-blade denticles anterior (and the proximal one posterior) of the cusp are of almost equal size but much smaller than all other denticles. The cusp is quite large and broad at the base, but not higher than the anterior denticle-set. The posterior blade is partly broken so that the position of the basal platform (whether centred or posterior to mid-length) is uncertain. The platform has rounded but asymmetrical lobes in upper view, with one of them being wider. The axis of the blade is arched with a slightly deformed anterior process. The lower margin is stepped, and straight in either profile (anterior and posterior). The anterior lower margin joins the anterior margin at nearly a right angle.

Remarks: In the original diagnosis of *Pandorinellina optima postoptima* new ssp. of FARRELL (2003), a raised and slightly arched posterior lower margin is one of the diagnostic features, distinguishing the subspecies *optima* and *postoptima* from each other. Additional features are the horizontal to inclined anterior lower margin and a platform located in the centre or just posterior to it. A range from the *pesavis* to *dehiscens* Zones is proposed for *Pand. o. postoptima*. The emended diagnosis of *Pand. o. optima* refers to a straight to slightly downwardly curving lower margin on either side along the blade-axis and a central basal cavity. The nominate ssp. enters earlier in the *delta* Zone (possibly *eurekaensis* Zone) and extends until late in the *pesavis* Zone (possibly *sulcatus* Zone). Additional information about ranges and relations of species within the Optima group are given by FARRELL (2003, Fig. 7, therein). The present specimens occur in the middle to late *delta* Zone but, due to the stepped but straight posterior lower margin, the illustrated one could be a form transitional to an early *Pand. optima postoptima*. Because of the differing outline of the holotype of that subspecies (LANE & ORMISTON, 1979, Pl. 3, Fig. 10) and the specimen figured by FARRELL (2003), the illustrated Pa element was assigned to *Pand. o. optima*.

Pandorinellina steinhornensis praeoptima (MASHKOVA, 1972)

Pl. 20, Fig. 1

Material: 2 specimens.

Pa element (Pl. 20, Fig. 1)

1979 *Pandorinellina steinhornensis praeoptima* (MASHKOVA) – LANE & ORMISTON, p. 59; Pl. 3, Fig. 1; Pl. 4, Figs. 10, 11.
1991 *Pandorinellina steinhornensis praeoptima* (MASHKOVA) sensu LANE & ORMISTON, 1979 – UYENO, Pl. 1, Fig. 19.

Description: The blade of the Pa elements is very low with a straight axis. Denticles are short, subequal in height and fused at the base. A few smaller denticles are present in the mid-blade area. The cusp is not enlarged. The upper profile is nearly straight along the remaining part of the anterior process. The distal part of the posterior process is slightly bowed due to decreasing height of the posteriormost denticles. The basal platform is asymmetrical with rounded, almost tongue-like lobes. The platform possibly has a position posterior to mid-length, with the upper surface of the lobes unornamented. A narrow pinch zone is visible in the lower part of the blade in lateral view.

Remarks: Both specimens are closest to one illustrated by LANE & ORMISTON (1979, Pl. 4, Figs. 10, 11) except for the number of denticles and the curvature of the axis of the blade. Their specimen has an equally low blade. Furthermore it has a similar arrangement of mid-blade denticles alternating in size, but whether this is a significant feature or not is uncertain; only a few Pa elements are referred to *Pand. steinhornensis praeoptima* in the literature.

Pandorinellina sp.

Pl. 12, Fig. 12; Pl. 20, Figs. 4, 5, 8

Material: 7 specimens.

Sa element (Pl. 12, Fig. 12)

Remarks: Two diplododellan Sa elements with a short denticulate posterior process are found in the lower part of the Seewarte section. No further assignment can be made, as Pa elements of *Pandorinellina* are lacking within the conodont assemblage of the same bed.

Pa element (Pl. 20, Figs. 4, 5, 8)

Description: One of the figured specimens (Plate 20, Fig. 5) has a rather low blade with 4 somewhat larger anterior denticles, followed by 2 very small, and 6 relative broad ones. The axis of the blade is straight. The platform is symmetrical, with both lobes widest beneath the cusp, tapering to a point distally. The basal cavity is open and moderately deep. The lower profile is straight within the anterior one-third and continues bowed to the posterior end.

Other Pa elements obtained (Plate 20, Figs. 4, 8), show an almost straight anterior axis of the blade, whereas the posterior one is arched. The anterior blade has about 9 denticles and the posterior one 6 to 8. The cusp and the denticles are of almost equal height with a slightly bowed to straight upper profile. The tips of the denticles point slightly posteriorly. The platform is asymmetrical and is located in the posterior half of the blade. One of the lobes is wider and subrectangular to tongue-like. The second lobe is rounded to heart-shaped. In lower view, the margin of the basal cavity flares from the distal end of the posterior process. The anterior groove is narrow proximally, tapering to a point distally. The lower margin is straight to gently bowed with the distal end of the posterior blade pointing downwards. The latter two specimens are similar to *Pand. steinhornensis steinhornensis* (ZIEGLER, 1956).

UNKNOWN

"Apparatus A" MASTANDREA, 1985a

Pl. 13, Figs. 14, 15, 16; Pl. 14, Fig. 1

General Remarks: Elements obtained are nearly identical to those figured by MASTANDREA (1985a) as "Apparatus A" from the Fluminese area (southwestern Sardinia). They occur in association with conodonts referred to the mid-Lochkovian *delta* Zone.

Material: 26 specimens.

Sb element (Pl. 13, Fig. 14?)

1985a "Apparatus A" MASTANDREA, p. 256; Pl. 3; Fig. 17?

Description: Elements have a high, adpressed blade with rather long denticles. The axis of the blade is almost straight. Denticles are nearly uniform, discrete, and aligned. They are compressed laterally with a lenticular cross-section. Denticles of the anterior process are slightly curved with their tips pointing to the inner side. Similarly, those of the posterior process are gently incurved and point slightly posteriorly. The cusp is similar in size and shape to the denticles. The basal cavity is narrow with the outer margin of the inner extension pointing posteriorly. The margin on the outer side of the basal cavity is rounded, but is less wide. Basal grooves are open proximally, tapering to a point along the anterior process and becoming adpressed posteriorly. The lower margin of both processes includes an angle of about 60 to 65 degrees. The entire element has a granular texture. This is apparently not due to acid-leaching, as only "Apparatus A" elements among the material from samples Se/01/15/04 and Se/01/16/04 have this pattern.

Sc element (Pl. 13, Fig. 15?)

1985a "Apparatus A" MASTANDREA, p. 256; Pl. 3; Fig. 16.
1998a "Apparatus A" MASTANDREA in CORRADINI, FERRETTI & SERPAGLI, Pl. 2.3.1, Fig. 11 [= specimen Pl. 3, Fig. 16; MASTANDREA, 1985a].

Remarks: The Sc element is similar in general features to the Sb element but differs in that the mid-blade denticles are more inwardly curved, with those of the posterior process conspicuously pointing in posterior direction. The basal cavity is totally flattened on the outer side, less wide, and more symmetrical on the inner side. Both basal grooves run adpressed towards either distal margin. The lateral processes include an angle of 80 to 85 degrees.

M element (Pl. 13, Fig. 16; Pl. 14, Fig. 1)

1985a "Apparatus A" MASTANDREA, p. 256; Pl. 3; Figs. 11, 13.
1998a "Apparatus A" MASTANDREA = CORRADINI, FERRETTI & SERPAGLI, Pl. 2.3.1, Fig. 10 [= specimen Pl. 3, Fig. 11; MASTANDREA, 1985a].

Description: Elements have long, steeply descending processes with palisade-like denticulation. In lower view the blade axis is not straight. The inner wall of the anterior lower margin continues as a rather straight line to the anterior lower margin of the cusp. By contrast, the inner wall of the posterior lower margin is curved relative to the posterior margin of the cusp and is slightly angular with its vertex where the posterior process meets the cusp. The angle between the anterior and posterior processes (outer side) is about 160 degrees. Thus only a projected angle (70 to 85 degrees) including the lower profile of the lateral processes can be measured. The anterior process has at least 14 to 16 denticles and the posterior one 12 to 16. Because of breakage, the precise number of denticles cannot be determined for either process. The denticles are rather small with elliptical cross-section. The basal cavity is moderately deep, extending to the inner side with a pronounced rounded margin, producing a prominent cusp. The cusp and mid-blade denticles are curved inward. The basal grooves are moderately deep and remain open distally.

Unassigned elements

Pl. 5, Figs. 5, 13; Pl. 6, Figs. 12, 18–20; Pl. 7, Figs. 6, 8, 9, 11; Pl. 10, Fig. 4; Pl. 11, Figs. 12–14; Pl. 12, Figs. 3, 4, 13–15; Pl. 13, Figs. 4, 6, 7, 10–12; Pl. 15, Figs. 3, 4, 6–10, 13–15; Pl. 17, Fig. 14; Pl. 18, Figs. 3, 6; Pl. 19, Figs. 4, 6; Pl. 20, Figs. 9, 12

Material: Approximately 11301 specimens.

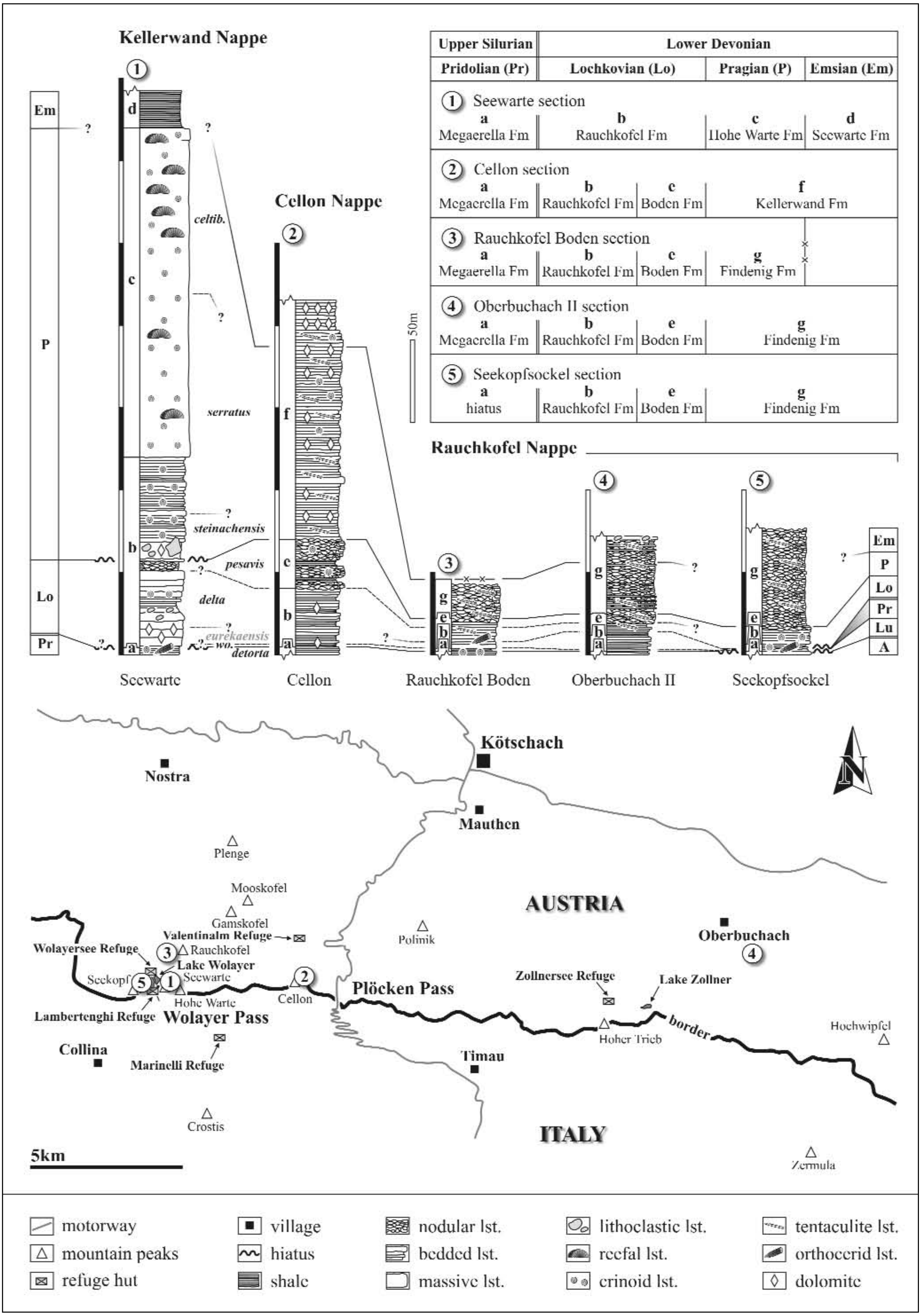
Remarks: Several specimens figured on plate 4 to 21 (S, M and P elements of various taxa) are referred to as "unassigned coniform element" or, where the position of the element can be determined, as "unassigned specimen", resulting from poor preservation, loss of taxonomically important features or, for some taxa, lacking Pa elements vital for determination. Though unassigned, they document the range of elements obtained.

10. Discussion and Conclusion

Compared to the pelagic Lower Devonian strata of the Barrandian area (CHLUPÁČ & KUKAL, 1977; CHLUPÁČ et al., 1985; CHLUPÁČ & OLIVER, 1989; CHLUPÁČ et al., 1998; CHLUPÁČ & HLADIL, 2000) and coeval sections in the Carnic Alps (SCHÖNLAUB, 1985a and 1985b; SCHÖNLAUB et al., 2004), the yield of rich conodont faunas for correlation in relation to biozonal boundaries suffers from the generally neritic nature of the Mount Seewarte depositional area. Additional geochemical methods were used as a tool for stratigraphic correlation. Stable isotopes ($\delta^{13}C$, $\delta^{18}O$) and magnetic susceptibility (ELLWOOD et al., 1999; CRICK et al., 2001; CARLS & SLAVÍK, 2005) were used to complement biostratigraphic data where index conodonts were lacking or very sparse. These investigations are still in progress; only isotope data are presented here.

The exposed uppermost part of the Megaerella Formation is assigned to the *detorta* Zone. The boundary to the adjacent Lower Devonian *woschmidti* Zone cannot be drawn with certainty due to lack of the distinctive I elements of *Icriodus woschmidti* or index graptolites, i.e. *M. uniformis*. The Silurian-Devonian boundary is estimated close to the occurrence of *Oulodus elegans detorta, Belodella anomalis, Icriodus* sp. and the overlapping interval of *Ozarkodina* aff. *O. remscheidensis eosteinhornensis* and *O. remscheidensis remscheidensis* marking the uppermost portion of the Pridoli Series (compare KLAPPER, 1977). Better results are provided by carbon isotopes. In Northern America (SALTZMAN, 2002) as well as in the Prague Syncline, and the slope to pelagic sequences of the Carnic Alps (BUGGISCH & MANN, 2004), a strong positive excursion from the latest *detorta* to the latest *woschmidti* Zone is evident. Such a positive trend was also observed in the investigated section, but without showing such high values across the Silurian-Devonian boundary. It thus may be concluded, that there may be a sedimentary gap in the earliest Devonian in the neritic succession of the Seewarte.

Text-Fig. 9.
Correlation of Lower Devonian units belonging to the Kellerwand Nappe (Seewarte section), Cellon Nappe (Cellon section) and Rauchkofel Nappe (Rauchkofel Boden, Oberbuchach II and Seekopfsockel sections), representing the shallow marine to pelagic transition.
A = 'Ashgillian'; Em = Emsian; Lo = Lochkovian; Lu = Ludfordian; P = Pragian; Pr = Pridolian; celtib. = celtibericus Zone; wo. = woschmidti Zone; lst. = limestone.


Kellerwand Nappe
Cellon Nappe
Rauchkofel Nappe
Upper Silurian
Lower Devonian
Pridolian (Pr)
Lochkovian (Lo)
Pragian (P)
Emsian (Em)
1 Seewarte section
a Megaerella Fm
b Rauchkofel Fm
c Hohe Warte Fm
d Seewarte Fm
2 Cellon section
a Megaerella Fm
b Rauchkofel Fm
c Boden Fm
f Kellerwand Fm
3 Rauchkofel Boden section
a Megaerella Fm
b Rauchkofel Fm
c Boden Fm
g Findenig Fm
4 Oberbuchach II section
a Megaerella Fm
b Rauchkofel Fm
e Boden Fm
g Findenig Fm
5 Seekopfsockel section
a hiatus
b Rauchkofel Fm
e Boden Fm
g Findenig Fm
50m
celtib.
serratus
steinachensis
pesavis
delta
eurekaensis
wo.
detorta
Seewarte
Cellon
Rauchkofel Boden
Oberbuchach II
Seekopfsockel
Em
P
Lo
Pr
Lu
A
Kötschach
Nostra
Mauthen
Plenge
Mooskofel
Gamskofel
Valentinalm Refuge
Wolayersee Refuge
Rauchkofel
Lake Wolayer
Seekopf
Seewarte
Hohe Warte
Lambertenghi Refuge
Wolayer Pass
Cellon
Plöcken Pass
Polinik
AUSTRIA
Oberbuchach
Zollnersee Refuge
Lake Zollner
Hoher Trieb
border
Hochwipfel
Collina
Marinelli Refuge
Timau
Crostis
ITALY
Zermula
5km
N
motorway
mountain peaks
refuge hut
village
hiatus
shale
nodular lst.
bedded lst.
massive lst.
lithoclastic lst.
reefal lst.
crinoid lst.
tentaculite lst.
orthocerid lst.
dolomite

Contrastingly, the Lochkovian *delta* Zone yields abundant conodonts enabling clear discrimination of its lower and upper boundary. The boundary of the base of the *delta* Zone is confirmed by the first occurrence of *Lanea omoalpha* in sample Se/01/07/04. The upper boundary is located some metres above the last occurrence of *Ancyrodelloides transitans* (Se/02/06a/05), between samples Se/02/07/04 and Se/02/08/04. Because no distinct I elements of *Pedavis pesavis* were obtained (only S and M elements of *Pedavis* sp. in a rather poor conodont fauna) less precision can be presented regarding the *pesavis* Zone.

Remarks on the Lower Devonian conodont zonation in relation to conodont crises in the latest *delta* to *pesavis* Zones have been presented by CARLS (1987) and VALENZUELA-RÍOS (1994b). A similar disappointingly poor conodont fauna continues from the base of the megaclast horizon from near the middle of the Rauchkofel Formation to the top of the Hohe Warte Formation. The first I elements of both morphotypes of *Latericriodus steinachensis* were obtained at the megaclast horizon. No Pa elements of any species of *Eognathodus*, neither *sulcatus sulcatus*, nor *sulcatus kindlei*, characteristic of the lower and middle Pragian, were encountered. However, an alternative conodont zonation for the Pragian proposed by SLAVÍK (2004b) confirmed a Pragian age for the upper Rauchkofel and Hohe Warte formations.

Obtained specimens of demonstrated stratigraphic value were *Latericriodus steinachensis* eta morph, *Pelekysgnathus* sp. and one element of *Caudicriodus* aff. *C. celtibericus*.

Stable isotopes across the suggested Lochkovian/Pragian-boundary show a sudden positive shift near the base of the megaclast horizon. A similar positive excursion is reported for the stage boundary for the stratotype section in the Barrandian by HLADÍKOVÁ et al. (1997).

Greater difficulty was experienced in trying to trace the biostratigraphic level and determine the precise age of the uppermost part of the Hohe Warte Formation; neither conodonts nor stable isotopes gave conclusive results, but an age not younger than upper Pragian seems reasonable. The total range of *Pelekysgnathus* sp. marks a rather long-lasting interval compared with the *steinachensis* Zone, which conforms to the proportion of the biozones as proposed by SLAVÍK, 2004b (page 61, Table 8). Moreover, this interval corresponds with an increased thickness of presumably continuous, shallow marine sediments. With respect to definition of the Pragian/Emsian-boundary (YOLKIN et al., 1997), distinctive conodonts, especially polygnathids or specimens of *Latericriodus bilatericrescens gracilis* (both indicative of Lower Emsian strata) were not encountered in the recently collected samples. A fragment of a supposed *Polygnathus* sp. indet. and elements of *Icriodus expansus* reported by BANDEL (1969) and VAI (1973) remain unconfirmed.

The most interesting interval in the Seewarte section is the upper *pesavis* or lower *steinachensis* Zone (= *sulcatus* Zone) megaclast horizon; approximating the Lochkovian/Pragian boundary according to the carbon isotope excursion. Whether or not it reflects events in shallow marine contexts associated with the *pesavis* Event (TALENT et al., 1993) cannot be unequivocally answered, though it is possible. Decrease in diversity of conodont taxa coupled with decreased abundance of conodont specimens is obvious and is consistent with an extinction event, but is not necessarily compelling. It could reflect no more than differences in preservation in different platform facies. Moreover, discrimination of life-crises in environmentally changeable shallow-water contexts, reflecting complex land-sea interactions, with sedimentary gaps, appears inherently more difficult than with more continuous pelagic sequences. The correlation of the shallow marine succession at the Seewarte (Kellerwand Nappe) with other sections from the transitional facies (Cellon Nappe) and the pelagic facies (Rauchkofel Nappe) in Text-Fig. 9, clearly shows a lithological change at this boundary throughout all logs.

Plate 1

Fig. A: Coated grain grainstone; MF-type 2.
IPUW-3803–1–2, Se/01/02/04.
Megaerella Formation; thin section.

Fig. B: Bioclastic grainstone; major components are crinoid stem plates; MF-type 2.
IPUW-3803–1–3, Se/01/03/04.
Megaerella Formation; thin section.

Fig. C: *Ozarkodina excavata excavata*; two Pa elements in sparitic matrix.
IPUW-3803–1–3, Se/01/03/04.
Megaerella Formation; thin section.

Fig. D: Peloidal pack-/grainstone with bioclastic components; MF-type 3a.
IPUW-3803–1–9, Se/01/09/04.
Rauchkofel Formation; thin section.

Fig. E: Dolomite; only a few relicts of crinoid stem plates of the primary facies are preserved.
IPUW-3803–1–11, Se/01/11/04.
Rauchkofel Formation; thin section.

Fig. F: Peloidal pack-/grainstone with bioclastic components; MF-type 3a.
IPUW-3803–1–17, Se/01/17/04.
Rauchkofel Formation; thin section.

Fig. G: Micritic matrix with densely packed small bioclasts, pyrite and concentrations of dolomitic grains along stylolites; MF-type 8?
IPUW-3803–2–10, Se/02/10/04.
Rauchkofel Formation; thin section.

Fig. H: Probably resedimented cluster of *Girvanella* tubes growing around siliciclastic grains or calcareous skeletal remains substituted by secondary sparite during diagenesis.
IPUW-3803–2–12, Se/02/12/04.
Rauchkofel Formation; thin section.

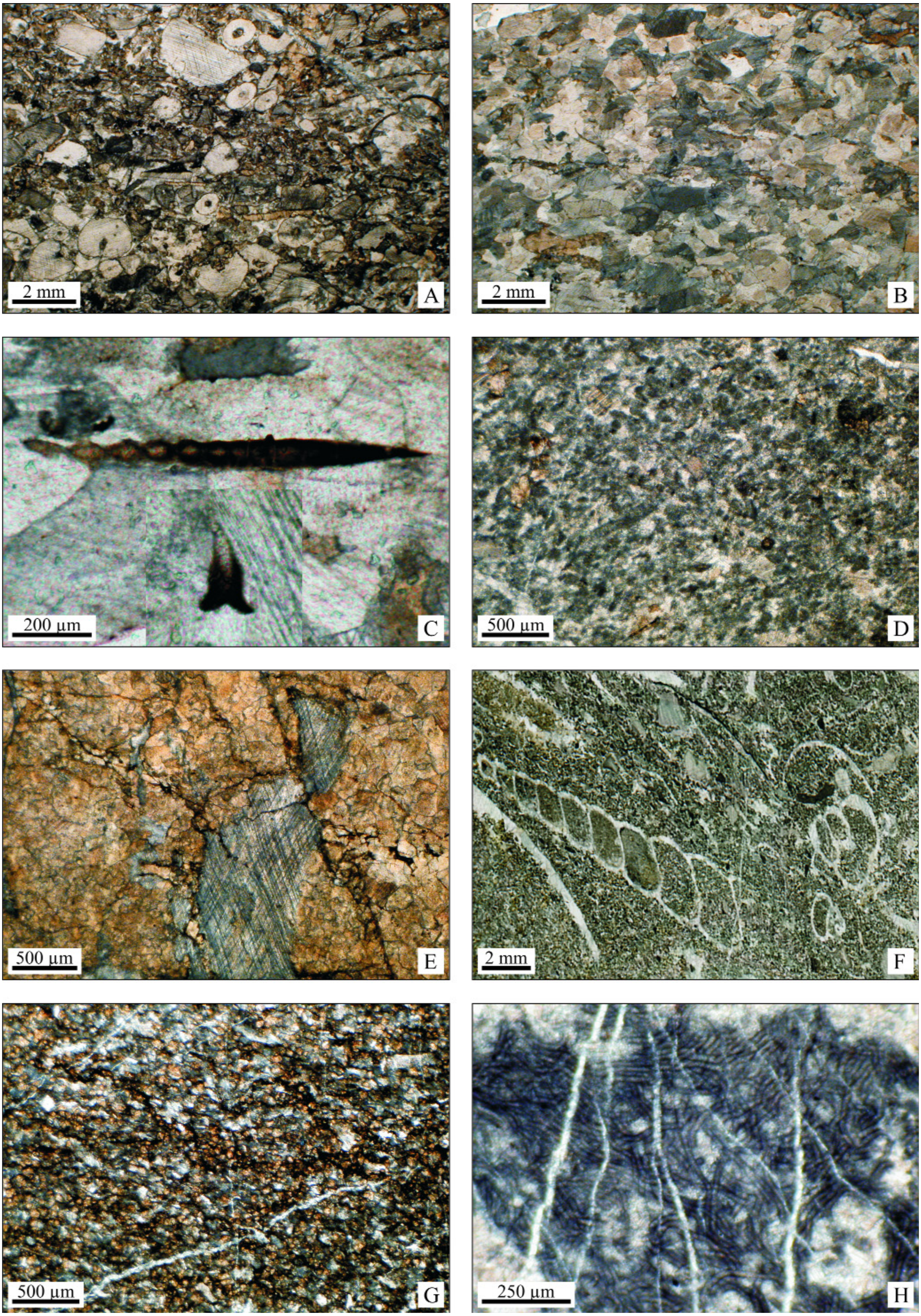

2 mm
A
2 mm
B
200 µm
C
500 µm
D
500 µm
E
2 mm
F
500 µm
G
250 µm
H

Plate 2

Fig. A: Dolomitic matrix of the megaclast horizon; consisting of poorly sorted skeletal grains dominated by crinoid stem plates; components are densely packed (for about 2 cm) around the megaclasts, becoming loosely packed to dispersed with increasing distance, MF-type 3a.
IPUW-3803–2–15c, Se/02/15c/05.
Rauchkofel Formation; thin section.

Fig. B: Rudstone, breccia of reefal debris, MF-type 6.
IPUW-3803–2–17, Se/02/17/04.
Rauchkofel Formation; thin section.

Fig. C: Dolomite vugh, zonal texture shows dolomite rhombohedrons increasing in size towards the buff-colored centre.
IPUW-3803–2–18, Se/02/18/04.
Rauchkofel Formation; thin section.

Fig. D: Bioclastic pack-/grainstone with subordinate peloids, matrix partially dolomitized, MF-type 3a.
IPUW-3803–3–1, Se/03/01/04.
Rauchkofel Formation; thin section.

Fig. E: Rudstone, breccia of reefal debris, matrix partially dolomitized, MF-type 6.
IPUW-3803–3–2a, Se/03/02a/04.
Hohe Warte Formation; thin section.

Fig. F: Rudstone, breccia of reefal debris, matrix partially dolomitized, high-spired gastropod at centre, MF-type 6.
IPUW-3803–3–8, Se/03/08/04.
Hohe Warte Formation; thin section.

Fig. G: Rudstone, breccia of reefal debris, dominated by large crinoid stems, MF-type 6.
IPUW-3803–3–9, Se/03/09/04.
Hohe Warte Formation; thin section.

Fig. H: Bioclastic pack-/grainstone with two small *Renalcis* clusters.
IPUW-3803–3–12, Se/03/12/04.
Hohe Warte Formation; thin section.

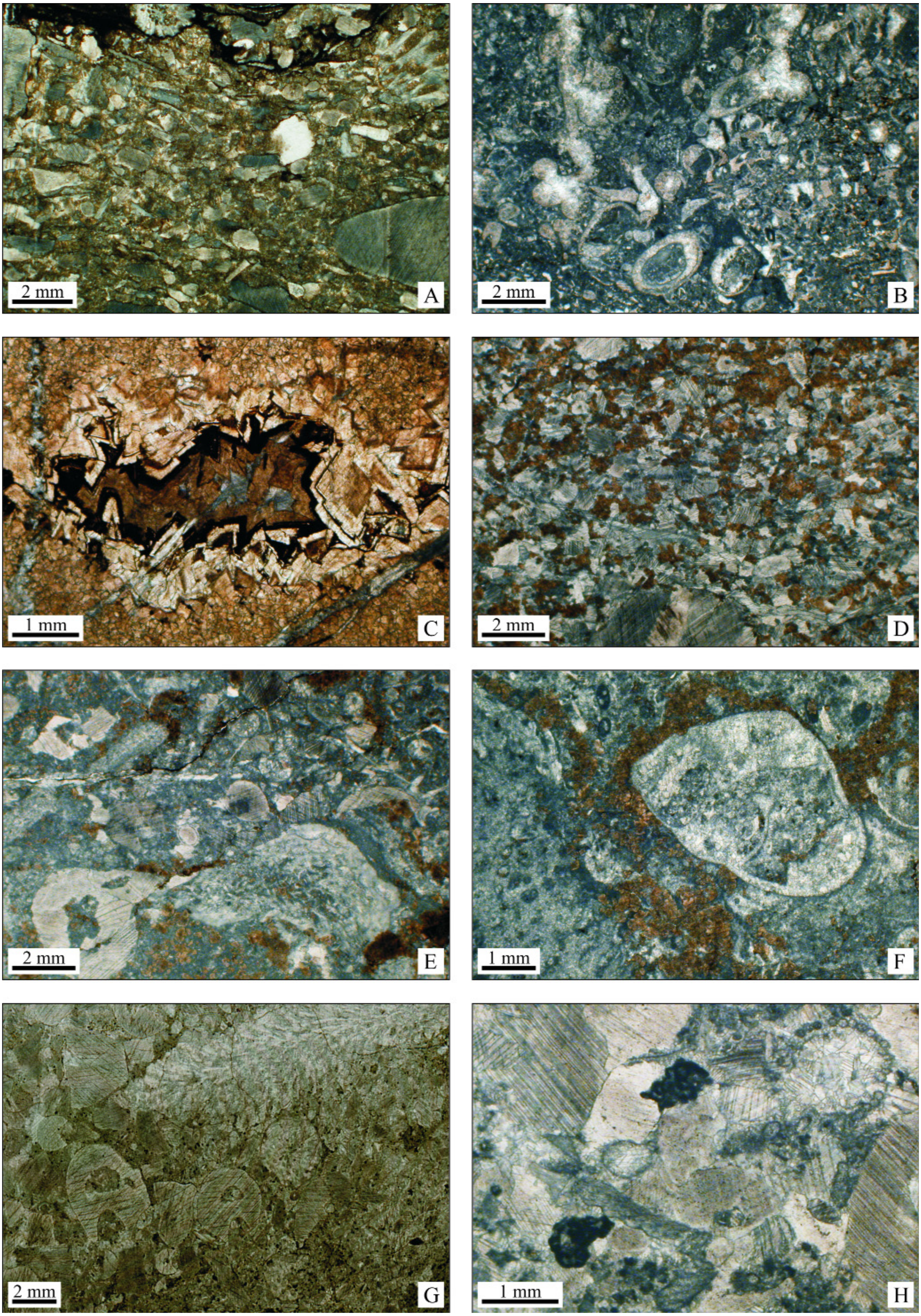

2 mm
A
2 mm
B
1 mm
C
2 mm
D
2 mm
E
1 mm
F
2 mm
G
1 mm
H

Plate 3

Fig. A: Crinoidal grainstone, capped at the top; sedimentation continues with bioclastic, peloidal pack-/grainstone.
IPUW-3803–3–44, Se/03/44/04.
Hohe Warte Formation; thin section.

Fig. B: Framestone; MF-type 5b.
IPUW-3803–4–3, Se/04/-10/04.
Hohe Warte Formation; thin section.

Fig. C: Rudstone; with udoteacean green algae and crinoid stem plates; MF-type 6.
IPUW-3803–4–4, Se/04/-09/04.
Hohe Warte Formation; thin section.

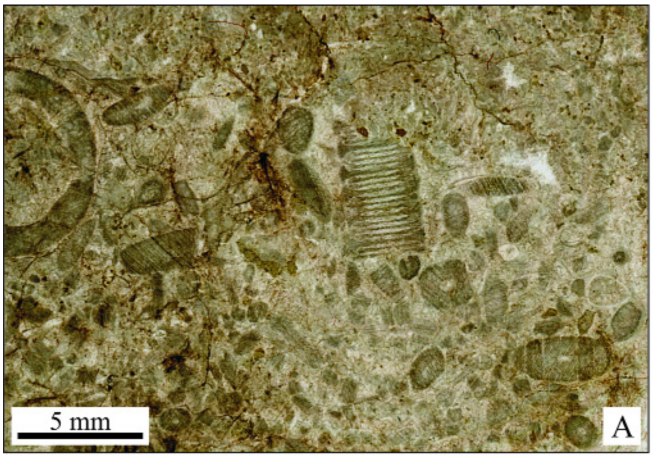
Fig. D: Framestone; major components are corals, stromatoporoids and encrusting algae (latter acting as sediment-binding organisms); MF-type 5b/c.
IPUW-3803–4–9, Se/04/-04/04.
Hohe Warte Formation; thin section.

Fig. E: Rudstone; consisting mainly of udoteacean green algae and calcimicrobes; MF-type 6.
IPUW-3803–4–12, Se/04/-01/04.
Hohe Warte Formation; thin section.

Fig. F: Rudstone; with *Orthonella* ? and *Renalcis*; MF-type 6.
IPUW-3803–4–14, Se/04/02/04.
Hohe Warte Formation; thin section.

Fig. G: Framestone; the main frame-building calcimicrobes belong to the *Renalcis* Group; MF-type 5b.
IPUW-3803–4–27, Se/04/15/04.
Hohe Warte Formation; thin section.

Fig. H: Bindstone with stromatactis (fenestral fabrics), *Garwoodia*, ostracod valves and gastropod shells; MF-type 5c.
IPUW-3803–5–1, Se/05/01/05.
Seewarte Formation; thin section.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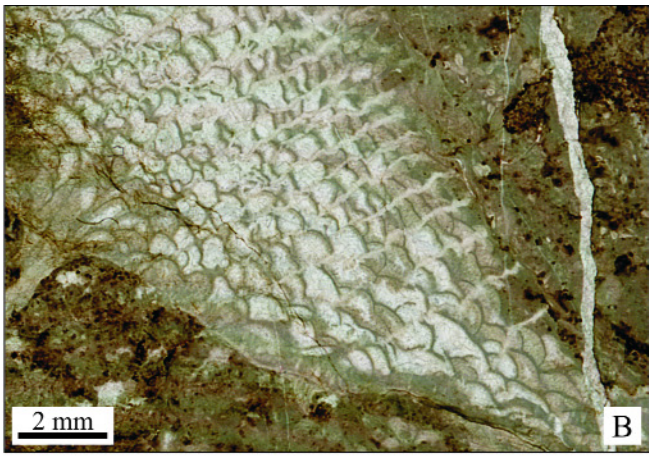
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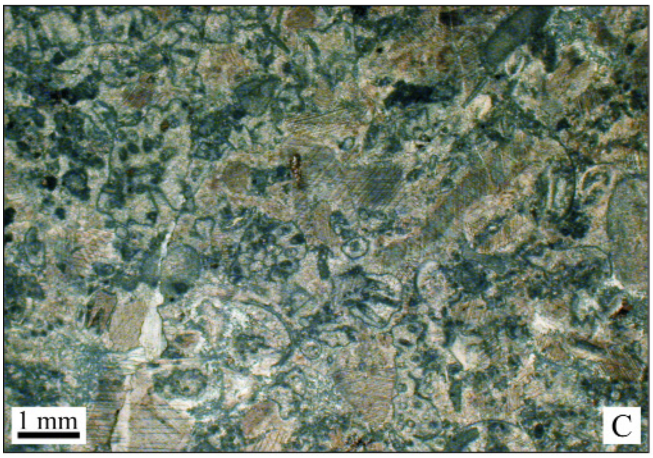
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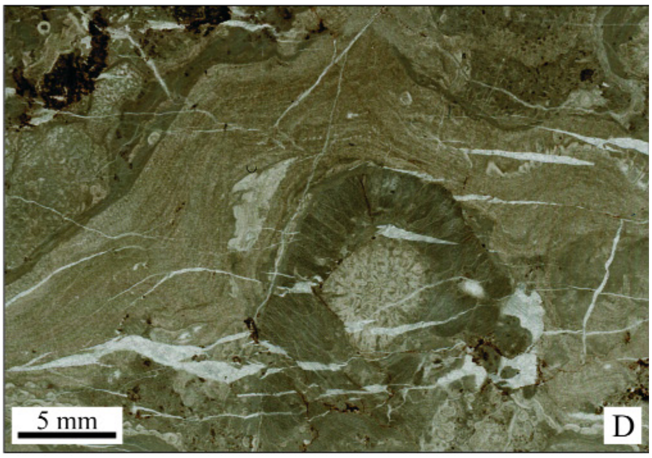
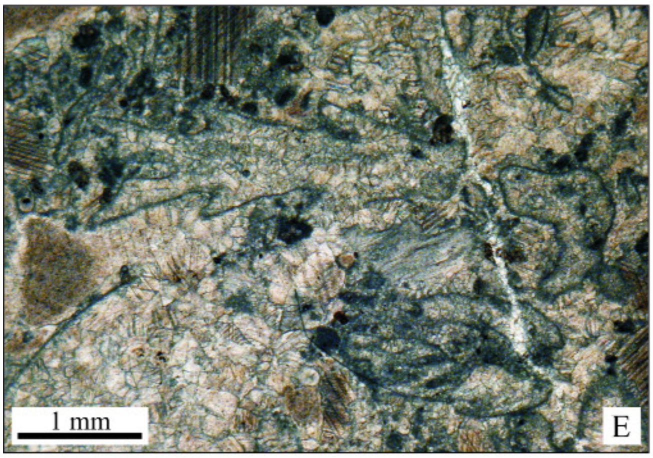

5 mm
D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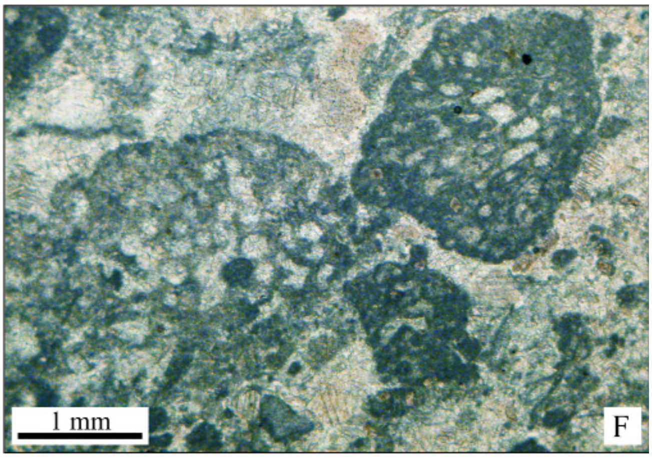
E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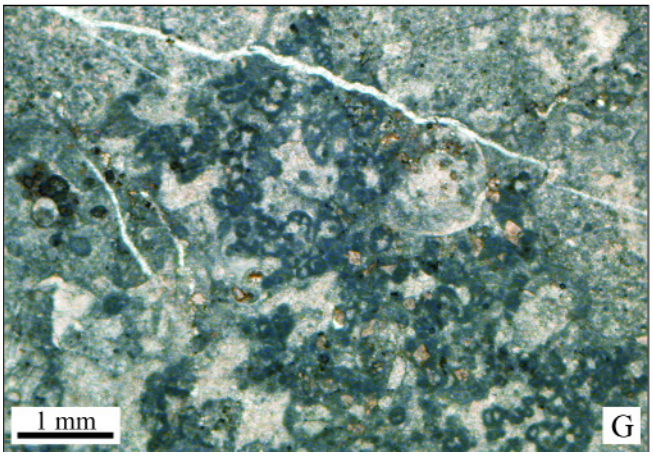
F


1 mm
G

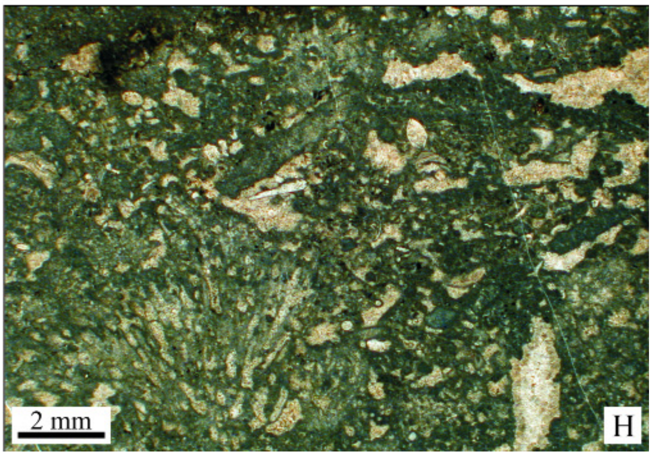

2 mm
H

Plate 4

Fig. 1: *Belodella anomalis* COOPER, 1974.
GBA-2006/1/14-31, Se/01/05/04.
Megaerella Formation.
Sd element.
a) Lateral view.
b) Lower view.

Fig. 2: *Belodella anomalis* COOPER, 1974.
GBA-2006/1/14-33, Se/01/05/04.
Megaerella Formation.
Sc element.
a) Lateral view.
b) Lower view.

Fig. 3: *Belodella anomalis* COOPER, 1974.
GBA-2006/1/14-30, Se/01/05/04.
Megaerella Formation.
Sd element.
a) Lateral view.
b) Lower view.

Fig. 4: *Belodella anomalis* COOPER, 1974.
GBA-2006/1/14-29, Se/01/05/04.
Megaerella Formation.
Sd element.
a) Lateral view.
b) Lower view.

Fig. 5: *Belodella anomalis* COOPER, 1974.
GBA-2006/1/14-32, Se/01/05/04.
Megaerella Formation.
Sa element.
a) Lateral view.
b) Lower view.
c) Posterior view.

Fig. 6: *Belodella anomalis* COOPER, 1974.
GBA-2006/1/14-34, Se/01/05/04.
Megaerella Formation.
Sb element.
a) Lateral view.
b) Lower view.
c) Anterior view.

Fig. 7: *Dvorakia* sp. A.
GBA-2006/1/14-14, Se/03/20/04.
Hohe Warte Formation.
Sa? element.
a) Lateral view.
b) Lower view.

Fig. 8: *Dvorakia* sp. A.
GBA-2006/1/14-15, Se/03/20/04.
Hohe Warte Formation.
Sb? element.
a) Lateral view.
b) Lower view.

Fig. 9: *Belodella resima* (PHILIP, 1965).
GBA-2006/1/08-11, Se/02/07/04.
Rauchkofel Formation.
Sc element.
a) Lateral view.
b) Lower view.

Fig. 10: *Belodella resima* (PHILIP, 1965).
GBA-2006/1/08-13, Se/02/07/04.
Rauchkofel Formation.
Sd element.
a) Lateral view.
b) Lower view.

Fig. 11: *Belodella resima* (PHILIP, 1965).
GBA-2006/1/08-09, Se/02/07/04.
Rauchkofel Formation.
Sb element.
a) Lateral view.
b) Lower view.

Fig. 12: *Belodella resima* (PHILIP, 1965).
GBA-2006/1/10-31, Se/02/17/04.
Rauchkofel Formation.
Sd element.
a) Lateral view.
b) Lower view.

Fig. 13: *Belodella striata* KOZUR, 1984.
GBA-2006/1/14-12, Se/03/20/04.
Hohe Warte Formation.
Sa element.
a) Lateral view.
b) Lower view.

Fig. 14: *Belodella resima* (PHILIP, 1965).
GBA-2006/1/13-28, Se/04/-11/04.
Hohe Warte Formation.
Sa element.
Lateral view.

Fig. 15: *Belodella resima* (PHILIP, 1965).
GBA-2006/1/10-39, Se/02/17/04.
Rauchkofel Formation.
Sa element.
a) Lateral view.
b) Lower view.

Fig. 16: *Belodella resima* (PHILIP, 1965).
GBA-2006/1/10-05, Se/02/02/04.
Rauchkofel Formation.
M element.
a) Lateral view.
b) Lower view.

Fig. 17: *Belodella striata* KOZUR, 1984.
GBA-2006/1/14-17, Se/03/20/04.
Hohe Warte Formation.
Sb element.
a) Lateral view.
b) Lower view.

Fig. 18: *Belodella resima* (PHILIP, 1965).
GBA-2006/1/14-13, Se/03/20/04.
Hohe Warte Formation.
Sb element.
a) Lateral view.
b) Lower view.

Fig. 19: *Belodella resima* (PHILIP, 1965).
GBA-2006/1/09-11, Se/03/42/04.
Hohe Warte Formation.
Sb element.
a) Lateral view.
b) Lower view.

Fig. 20: ? *Belodella striata* KOZUR, 1984.
GBA-2006/1/12-15, Se/02/07/04.
Rauchkofel Formation.
Sa? element.
a) Lateral view.
b) Lower view.

Fig. 21: *Belodella resima* (PHILIP, 1965).
GBA-2006/1/12-14, Se/02/07/04.
Rauchkofel Formation.
Sb? element.
a) Lateral view.
b) Lower view.

Fig. 22: *Belodella resima* (PHILIP, 1965).
GBA-2006/1/12-13, Se/02/07/04.
Rauchkofel Formation.
Sc element.
a) Lateral view.
b) Lower view.

Fig. 23: *Belodella resima* (PHILIP, 1965).
GBA-2006/1/12-12, Se/02/07/04.
Rauchkofel Formation.
Sc element.
a) Lateral view.
b) Lower view.

Fig. 24: *Belodella resima* (PHILIP, 1965).
GBA-2006/1/12-11, Se/02/02/04.
Rauchkofel Formation.
Sc element.
a) Lateral view.
b) Lower view.

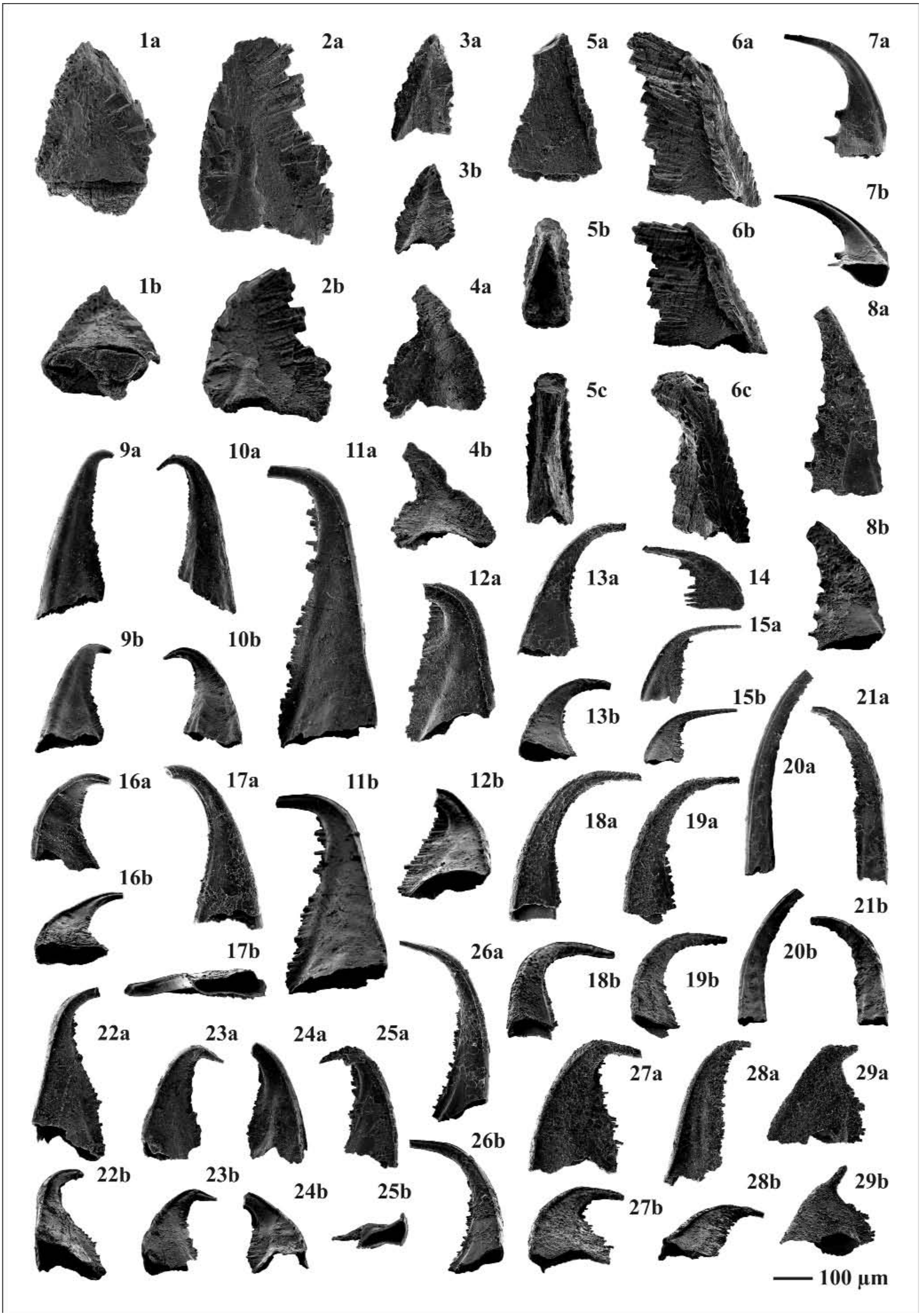
Fig. 25: *Belodella resima* (PHILIP, 1965).
GBA-2006/1/13-27, Se/04/-11/04.
Hohe Warte Formation.
Sc? element.
a) Lateral view.
b) Lower view.

Fig. 26: *Belodella striata* KOZUR, 1984.
GBA-2006/1/09-28, Se/04/-09/04.
Hohe Warte Formation.
Sa element.
a) Lateral view.
b) Lower view.

Fig. 27: *Belodella resima* (PHILIP, 1965).
GBA-2006/1/09-17, Se/04/-11/04.
Hohe Warte Formation.
Sa element.
a) Lateral view.
b) Lower view.

Fig. 28: *Belodella resima* (PHILIP, 1965).
GBA-2006/1/10-51, Se/04/-05/04.
Hohe Warte Formation.
T element.
a) Lateral view.
b) Lower view.

Fig. 29: ? *Belodella resima* (PHILIP, 1965).
GBA-2006/1/09-31, Se/04/03/04.
Hohe Warte Formation.
Sd element.
a) Lateral view.
b) Lower view.


1a
2a
3a
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6a
7a
3b
7b
5b
6b
1b
2b
4a
8a
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9a
10a
11a
4b
8b
12a
13a
14
9b
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22a
23a
24a
25a
27a
28a
29a
26b
22b
23b
24b
25b
27b
28b
29b
100 µm

Plate 5

Fig. 1: *Dvorakia* sp.
GBA-2006/1/09-22, Se/04/-11/04.
Hohe Warte Formation.
S? element.
a) Lateral view.
b) Lower view.

Fig. 2: *Dvorakia* sp.
GBA-2006/1/07-20, Se/02/02/04.
Rauchkofel Formation.
S? element.
a) Lateral view.
b) Lower view.

Fig. 3: *Belodella striata* KOZUR, 1984.
GBA-2006/1/16-06, Se/02/12/04.
Rauchkofel Formation.
M element.
a) Lateral view.
b) Lower view.

Fig. 4: *Dvorakia* sp.
GBA-2006/1/11-08, Se/01/06a/04.
Rauchkofel Formation.
S? element.
a) Lateral view.
b) Lower view.

Fig. 5: Unassigned coniform element.
GBA-2006/1/07-17, Se/02/02/04.
Rauchkofel Formation.
M? element.
a) Lateral view.
b) Lower view.

Fig. 6: *Dvorakia* sp.
GBA-2006/1/14-19, Se/03/20/04.
Hohe Warte Formation.
S? element.
a) Lateral view.
b) Lower view.

Fig. 7: *Panderodus* sp.
GBA-2006/1/01-09, Se/01/01/04.
Megaerella Formation.
a) Lateral view.
b) Lower view.

Fig. 8: *Panderodus* sp.
GBA-2006/1/01-05, Se/01/01/04.
Megaerella Formation.
a) Lateral view.
b) Lower view.

Fig. 9: *Panderodus* sp.
GBA-2006/1/01-17, Se/01/01/04.
Megaerella Formation.
a) Lateral view.
b) Lower view.

Fig. 10: *Dvorakia* sp.
GBA-2006/1/14-22, Se/01/01/04.
Megaerella Formation.
M element.
a) Lateral view.
b) Lower view.

Fig. 11: *Panderodus unicostatus* (BRANSON & MEHL, 1933).
GBA-2006/1/07-19, Se/02/02/04.
Rauchkofel Formation.
a) Lateral view.
b) Lower view.

Fig. 12: *Panderodus unicostatus* (BRANSON & MEHL, 1933).
GBA-2006/1/04-02, Se/01/06a/04.
Rauchkofel Formation.
a) Lateral view.
b) Lower view.

Fig. 13: Unassigned coniform element.
GBA-2006/1/01-08, Se/01/01/04.
Megaerella Formation.
a) Lateral view.
b) Lower view.

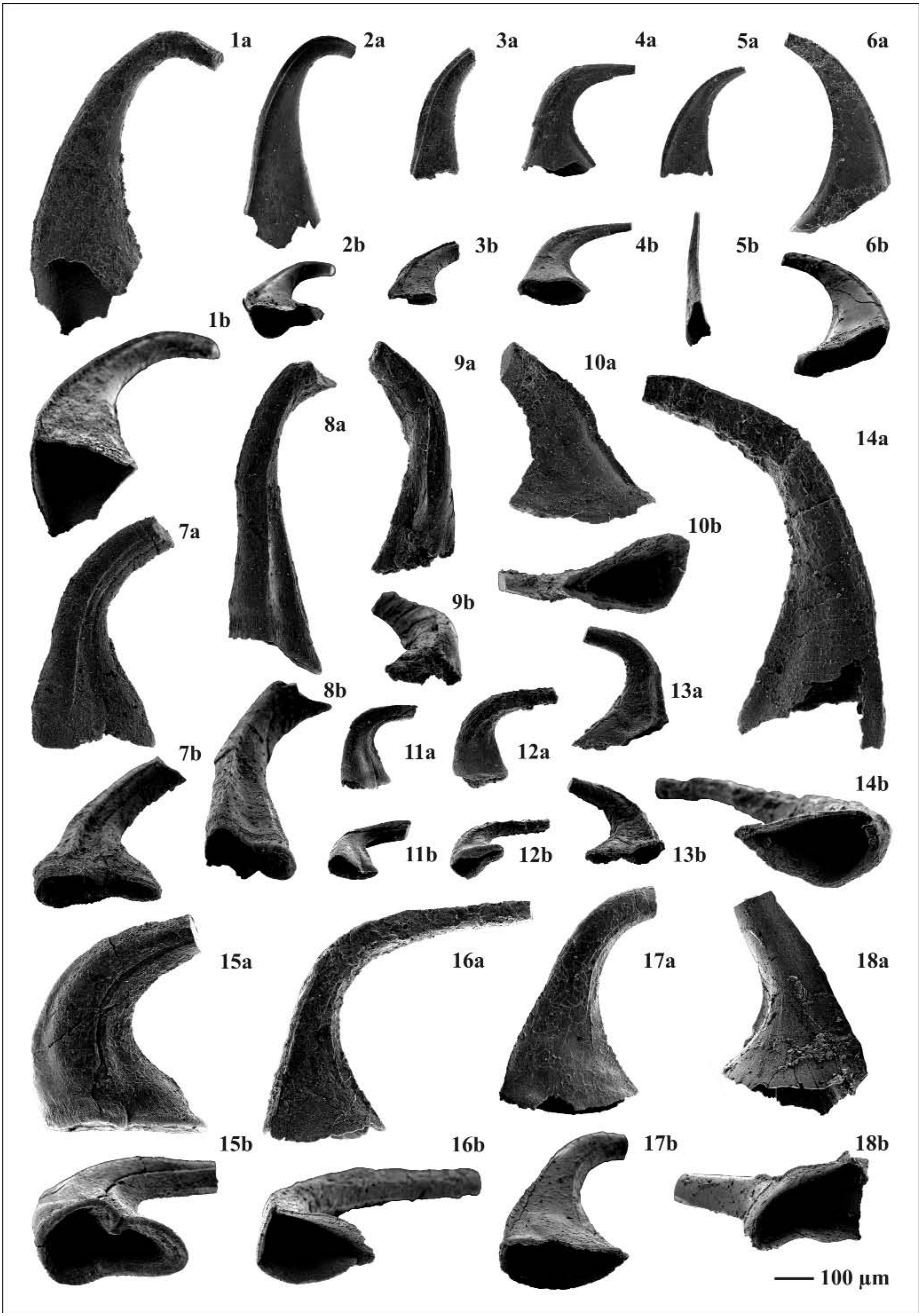
Fig. 14: *Dvorakia* sp.
GBA-2006/1/01-02, Se/01/01/04.
Megaerella Formation.
M element.
a) Lateral view.
b) Lower view.

Fig. 15: *Panderodus* sp.
GBA-2006/1/14-43, Se/01/05/04.
Megaerella Formation.
a) Lateral view.
b) Lower view.

Fig. 16: *Dvorakia* aff. *D. chattertoni* KLAPPER & BARRICK, 1983.
GBA-2006/1/14-28, Se/01/04/04.
Megaerella Formation.
Sb element.
a) Lateral view.
b) Lower view.

Fig. 17: *Dvorakia* aff. *D. chattertoni* KLAPPER & BARRICK, 1983.
GBA-2006/1/14-27, Se/01/03/04.
Megaerella Formation.
Sc element.
a) Lateral view.
b) Lower view.

Fig. 18: *Dvorakia* sp.
GBA-2006/1/12-34, Se/02/15c/05.
Rauchkofel Formation.
S? element.
a) Lateral view.
b) Lower view.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100 µm

Plate 6

Fig. 1: *Neopanderodus leptostriatus* ANDERSON, 2003.
GBA-2006/1/09-12, Se/03/42/04.
Hohe Warte Formation.
Sa? element.
a) Lateral view.
b) Lower view.

Fig. 2: *Panderodus unicostatus* (BRANSON & MEHL, 1933).
GBA-2006/1/14-18, Se/03/20/04.
Hohe Warte Formation.
a) Lateral view.
b) Lower view.

Fig. 3: *Panderodus unicostatus* (BRANSON & MEHL, 1933).
GBA-2006/1/14-09, Se/03/20/04.
Hohe Warte Formation.
a) Lateral view.
b) Lower view.

Fig. 4: *Panderodus unicostatus* (BRANSON & MEHL, 1933).
GBA-2006/1/13-16, Se/03/19/04.
Hohe Warte Formation.
a) Lateral view.
b) Lower view.

Fig. 5: *Panderodus unicostatus* (BRANSON & MEHL, 1933).
GBA-2006/1/09-32, Se/04/03/04.
Hohe Warte Formation.
a) Lateral view.
b) Lower view.

Fig. 6: *Neopanderodus aequabilis* TELFORD, 1975.
GBA-2006/1/08-23, Se/03/19/04.
Hohe Warte Formation.
Sa element.
a) Lateral view.
b) Lower view.

Fig. 7: *Neopanderodus aequabilis* TELFORD, 1975.
GBA-2006/1/10-48, Se/03/17/04.
Sa element.
Hohe Warte Formation.
a) Lateral view.
b) Lower view.

Fig. 8: *Panderodus* sp.
GBA-2006/1/10-22, Se/02/13/04.
Rauchkofel Formation; lateral view.

Fig. 9 *Neopanderodus* sp.
GBA-2006/1/09-02, Se/03/27/04.
Hohe Warte Formation.
Sc? element.
Lateral view.

Fig. 10: *Icriodus* sp.
GBA-2006/1/14-42, Se0/01/05a/05.
Rauchkofel Formation.
Adenticulate S element.
a) Lateral view.
b) Lower view.

Fig. 11: ? *Panderodus unicostatus* (BRANSON & MEHL, 1933).
GBA-2006/1/10-10, Se/02/05/04.
Rauchkofel Formation.
a) Lateral view (remark strongly deformed cusp).
b) Lower view.

Fig. 12: Unassigned coniform element.
GBA-2006/1/10-47, Se/03/17/04.
Hohe Warte Formation.
a) Lateral view.
b) Lower view.

Fig. 13: *Dvorakia klapperi* (CHATTERTON, 1974).
GBA-2006/1/09-29, Se/04/-09/04.
Hohe Warte Formation.
Sb? element.
a) Lateral view.
b) Lower view.

Fig. 14: *Walliserodus multistriatus* FARRELL, 2004.
GBA-2006/1/17-02, Se/01/05/04.
Megaerella Formation.
Sa? element.
a) Lateral view.
b) Lower view.

Fig. 15: *Icriodus* sp.
GBA-2006/1/17-01, Se/01/03/04.
Megaerella Formation.
Denticulate M2 element.
a) Lateral view.
b) Lower view.

Fig. 16: *Pseudooneotodus beckmanni* (BISCHOFF & SANNEMANN, 1958).
GBA-2006/1/08-15, Se/02/31/04.
Rauchkofel Formation.
a) Upper view.
b) Lateral view.

Fig. 17: *Pseudooneotodus beckmanni* (BISCHOFF & SANNEMANN, 1958).
GBA-2006/1/10-18, Se/02/13/04.
Rauchkofel Formation.
a) Lateral view.
b) Lower view.

Fig. 18: Unassigned coniform element.
GBA-2006/1/08-22, Se/03/13/04.
Hohe Warte Formation.
a) Lateral view.
b) Lower view.

Fig. 19: Unassigned coniform element.
GBA-2006/1/14-10, Se/03/20/04.
Hohe Warte Formation.
a) Lateral view.
b) Lower view.

Fig. 20: Unassigned coniform element.
GBA-2006/1/09-13, Se/04/-11/04.
Hohe Warte Formation.
a) Lateral view.
b) Lower view.

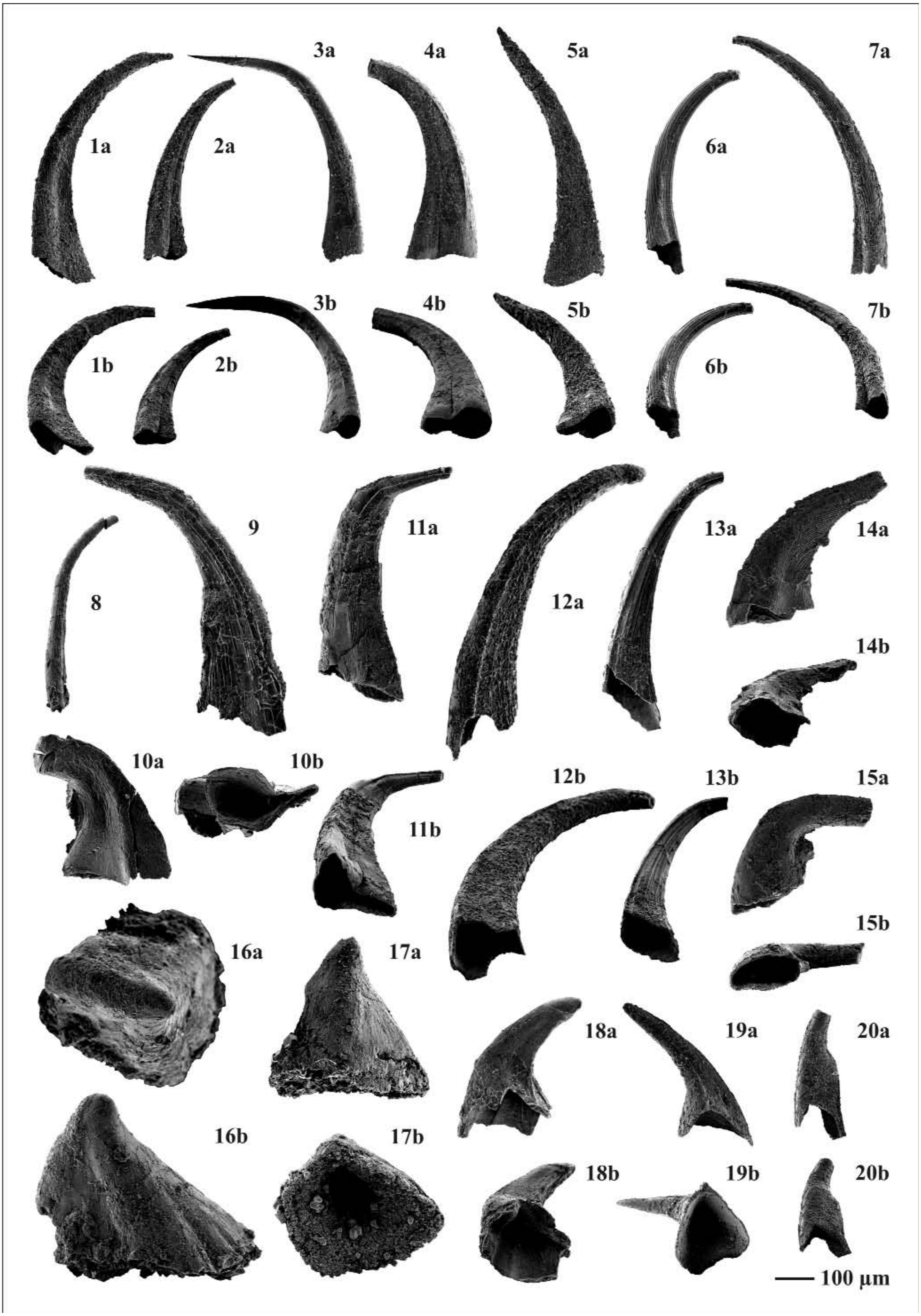
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Plate 7

Fig. 1: *Pseudooneotodus beckmanni* (BISCHOFF & SANNEMANN, 1958).
GBA-2006/1/10-19, Se/02/13/04.
Rauchkofel Formation.
Lateral view.

Fig. 2: *Pseudooneotodus beckmanni* (BISCHOFF & SANNEMANN, 1958).
GBA-2006/1/08-19, Se/03/07/04.
Hohe Warte Formation.
Oblique posterior view.

Fig. 3: *Pseudooneotodus beckmanni* (BISCHOFF & SANNEMANN, 1958).
GBA-2006/1/08-20, Se/03/07/04.
Hohe Warte Formation.
Lateral view.

Fig. 4: *Pseudooneotodus beckmanni* (BISCHOFF & SANNEMANN, 1958).
GBA-2006/1/10-15, Se/02/13/04.
Rauchkofel Formation.
a) Lateral view.
b) Lower view.

Fig. 5: *Dvorakia klapperi* (CHATTERTON, 1974).
GBA-2006/1/10-52, Se/04/13/04.
Hohe Warte Formation.
Sd element.
a) Lower view.
b) Lateral view.

Fig. 6: Unassigned coniform element.
GBA-2006/1/14-08, Se/03/20/04.
Hohe Warte Formation.
a) Lateral view.
b) Lower view.

Fig. 7: *Latericriodus* cf. *L. steinachensis* (AL-RAWI, 1977)
eta morph KLAPPER & JOHNSON, 1980.
GBA-2006/1/12-22, Se/02/07/04.
Rauchkofel Formation.
M2 element.
a) Posterior view.
b) Lower view.

Fig. 8: Unassigned coniform element.
GBA-2006/1/10-21, Se/02/13/04.
Rauchkofel Formation.
a) Lateral view.
b) Lower view.

Fig. 9: Unassigned coniform element.
GBA-2006/1/10-25, Se/02/13/04.
Rauchkofel Formation.
Lateral view.

Fig. 10: *Pedavis* sp.
GBA-2006/1/12-24, Se/02/11/04.
Rauchkofel Formation.
M2d element.
a) Lateral view.
b) Lower view.

Fig. 11: Unassigned coniform element.
GBA-2006/1/14-07, Se/03/20/04.
Hohe Warte Formation.
a) Lateral view.
b) Lower view.

Fig. 12: *Decoriconus fragilis* (BRANSON & MEHL, 1933).
GBA-2006/1/11-04, Se/01/06a/04.
Rauchkofel Formation.
Sb element.
a) Lateral view.
b) Lower view.

Fig. 13: *Decoriconus fragilis* (BRANSON & MEHL, 1933).
GBA-2006/1/12-19, Se/02/07/04.
Rauchkofel Formation,
Sb element.
a) Lateral view.
b) Lower view.

Fig. 14: *Decoriconus fragilis* (BRANSON & MEHL, 1933).
GBA-2006/1/15-07, Se/03/17/04.
Hohe Warte Formation.
Sa element.
a) Lateral view.
b) Lower view.

Fig. 15: *Decoriconus fragilis* (BRANSON & MEHL, 1933).
GBA-2006/1/10-20, Se/02/13/04.
Rauchkofel Formation.
Sa-Sb element.
a) Lateral view.
b) Lower view.

Fig. 16: *Decoriconus fragilis* (BRANSON & MEHL, 1933).
GBA-2006/1/12-17, Se/02/07/04.
Rauchkofel Formation.
Sa-Sb element.
a) Anterior view.
b) Lower view.

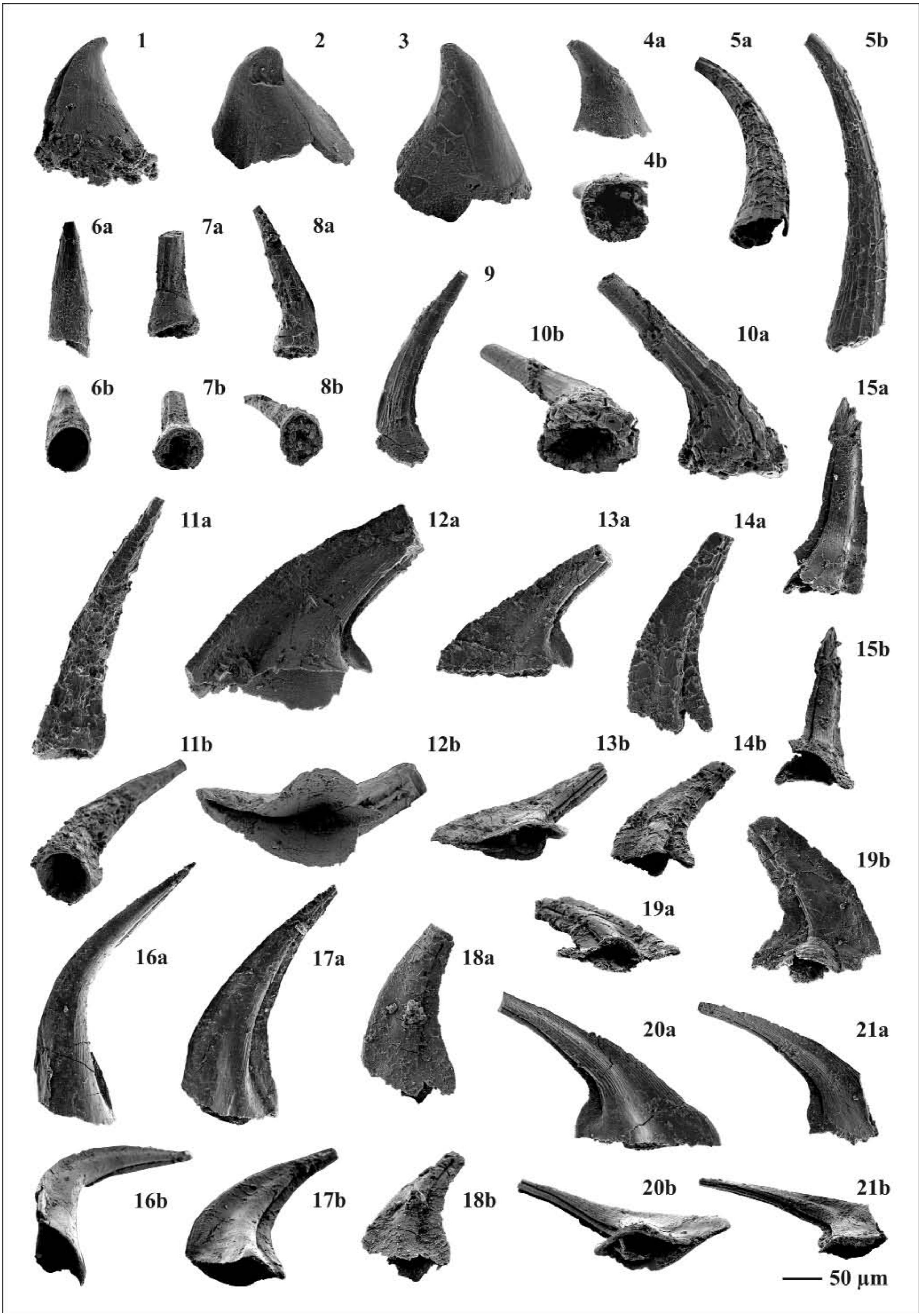
Fig. 17: *Decoriconus fragilis* (BRANSON & MEHL, 1933).
GBA-2006/1/12-20, Se/02/07/04.
Rauchkofel Formation.
Sa element.
a) Lateral view.
b) Lower view.

Fig. 18: *Decoriconus fragilis* (BRANSON & MEHL, 1933).
GBA-2006/1/10-30, Se/02/13/04.
Rauchkofel Formation.
Sa element.
a) Lateral view.
b) Lower view.

Fig. 19: *Decoriconus fragilis* (BRANSON & MEHL, 1933).
GBA-2006/1/10-24, Se/02/13/04.
Rauchkofel Formation.
Sb? element.
a) Lower view.
b) Lateral view.

Fig. 20: *Decoriconus fragilis* (BRANSON & MEHL, 1933).
GBA-2006/1/12-21, Se/02/07/04.
Rauchkofel Formation.
Sb element.
a) Lateral view.
b) Lower view.

Fig. 21: *Decoriconus fragilis* (BRANSON & MEHL, 1933).
GBA-2006/1/12-18, Se/02/07/04.
Rauchkofel Formation.
Sb element.
a) Lateral view.
b) Lower view.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21b
50 µm

Plate 8

Fig. 1: *Latericriodus* cf. *L. steinachensis* (Al-Rawi, 1977) beta morph Klapper & Johnson, 1980.
GBA-2006/1/13-03, Se/02/15b/05.
Rauchkofel Formation.
I element.
a) Lateral view.
b) Upper view.

Fig. 2: *Latericriodus steinachensis* (Al-Rawi, 1977) eta morph Klapper & Johnson, 1980.
GBA-2006/1/13-01, Se/02/15b/05.
Rauchkofel Formation.
I element.
a) Lateral view.
b) Lower view.

Fig. 3: *Latericriodus* cf. *L. steinachensis* (Al-Rawi, 1977) eta morph Klapper & Johnson, 1980.
GBA-2006/1/10-43, Se/03/02/04.
Rauchkofel Formation.
I element.
Upper view.

Fig. 4: ? *Latericriodus* sp.
GBA-2006/1/13-05, Se/02/33/04.
Rauchkofel Formation.
Juvenile I element.
a) Lateral view.
b) Lower view.

Fig. 5: *Latericriodus* cf. *L. steinachensis* (Al-Rawi, 1977) eta morph Klapper & Johnson, 1980.
GBA-2006/1/13-06, Se/03/05/04.
Hohe Warte Formation.
I element.
a) Lateral view.
b) Upper view.

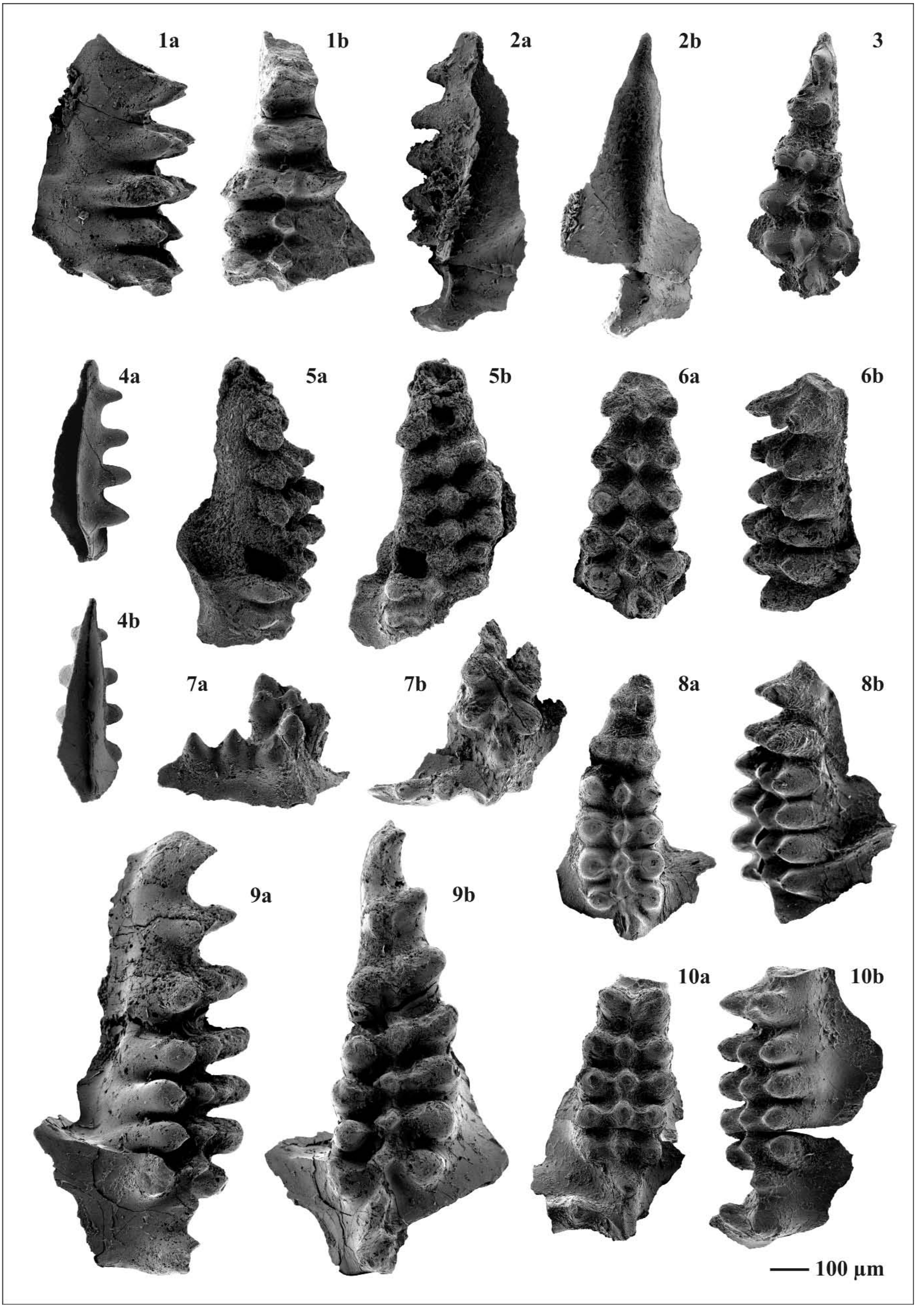
Fig. 6: *Latericriodus* cf. *L. steinachensis* (Al-Rawi, 1977) eta morph Klapper & Johnson, 1980.
GBA-2006/1/13-07, Se/03/05/04.
Hohe Warte Formation.
I element.
a) Upper view.
b) Lateral view.

Fig. 7: *Latericriodus* cf. *L. steinachensis* (Al-Rawi, 1977) eta morph Klapper & Johnson, 1980.
GBA-2006/1/13-02, Se/02/15b/05.
Rauchkofel Formation.
I element.
a) Posterior view.
b) Upper view.

Fig. 8: *Latericriodus steinachensis* (Al-Rawi, 1977) eta morph Klapper & Johnson, 1980.
GBA-2006/1/08-21, Se/03/13/04.
Hohe Warte Formation.
I element.
a) Upper view.
b) Lateral view.

Fig. 9: *Latericriodus steinachensis* (Al-Rawi, 1977) eta morph Klapper & Johnson, 1980.
GBA-2006/1/13-04, Se/02/15c/05.
Rauchkofel Formation.
I element.
a) Lateral view.
b) Upper view.

Fig. 10: *Latericriodus steinachensis* (Al-Rawi, 1977) eta morph Klapper & Johnson, 1980.
GBA-2006/1/13-19, Se/03/24/04.
Hohe Warte Formation.
I element.
a) Upper view.
b) Lateral view.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100 µm

Plate 9

Fig. 1: *Latericriodus steinachensis* (AL-RAWI, 1977) eta morph KLAPPER & JOHNSON, 1980.
GBA-2006/1/08-17, Se/02/31/04.
Rauchkofel Formation.
I element.
a) Upper view.
b) Lateral view.

Fig. 2: *Latericriodus* cf. *L. steinachensis* (AL-RAWI, 1977) eta morph KLAPPER & JOHNSON, 1980.
GBA-2006/1/13-23, Se/03/37/04.
Hohe Warte Formation.
I element.
a) Lateral view.
b) Upper view.

Fig. 3: *Latericriodus* cf. *L. steinachensis* (AL-RAWI, 1977) eta morph KLAPPER & JOHNSON, 1980.
GBA-2006/1/13-18, Se/03/24/04.
Hohe Warte Formation.
I element.
a) Upper view.
b) Lateral view.

Fig. 4: *Caudicriodus* aff. *C. celtibericus* (CARLS & GANDL, 1969).
GBA-2006/1/13-24, Se/03/45/05.
Hohe Warte Formation.
I element.
a) Upper view.
b) Lateral view.

Fig. 5: *Latericriodus steinachensis* (AL-RAWI, 1977) eta morph KLAPPER & JOHNSON, 1980.
GBA-2006/1/08-25, Se/03/22/04.
Hohe Warte Formation.
I element.
a) Lateral view.
b) Upper view.

Fig. 6: *Latericriodus steinachensis* (AL-RAWI, 1977) eta morph KLAPPER & JOHNSON, 1980.
GBA-2006/1/13-21, Se/03/29/04.
Hohe Warte Formation.
I element.
a) Upper view.
b) Lateral view.
c) Cross section of anterior part through second denticle row – detail shows lamellar interior structure.

Fig. 7: ? *Caudicriodus* sp.
GBA-2006/1/13-08, Se/03/14/04.
Hohe Warte Formation.
Juvenile I element.
a) Lateral view.
b) Upper view.

Fig. 8: *Latericriodus steinachensis* (AL-RAWI, 1977) eta morph KLAPPER & JOHNSON, 1980.
GBA-2006/1/13-30, Se/04/-07/04.
Hohe Warte Formation.
I element.
a) Upper view.
b) Lateral view.

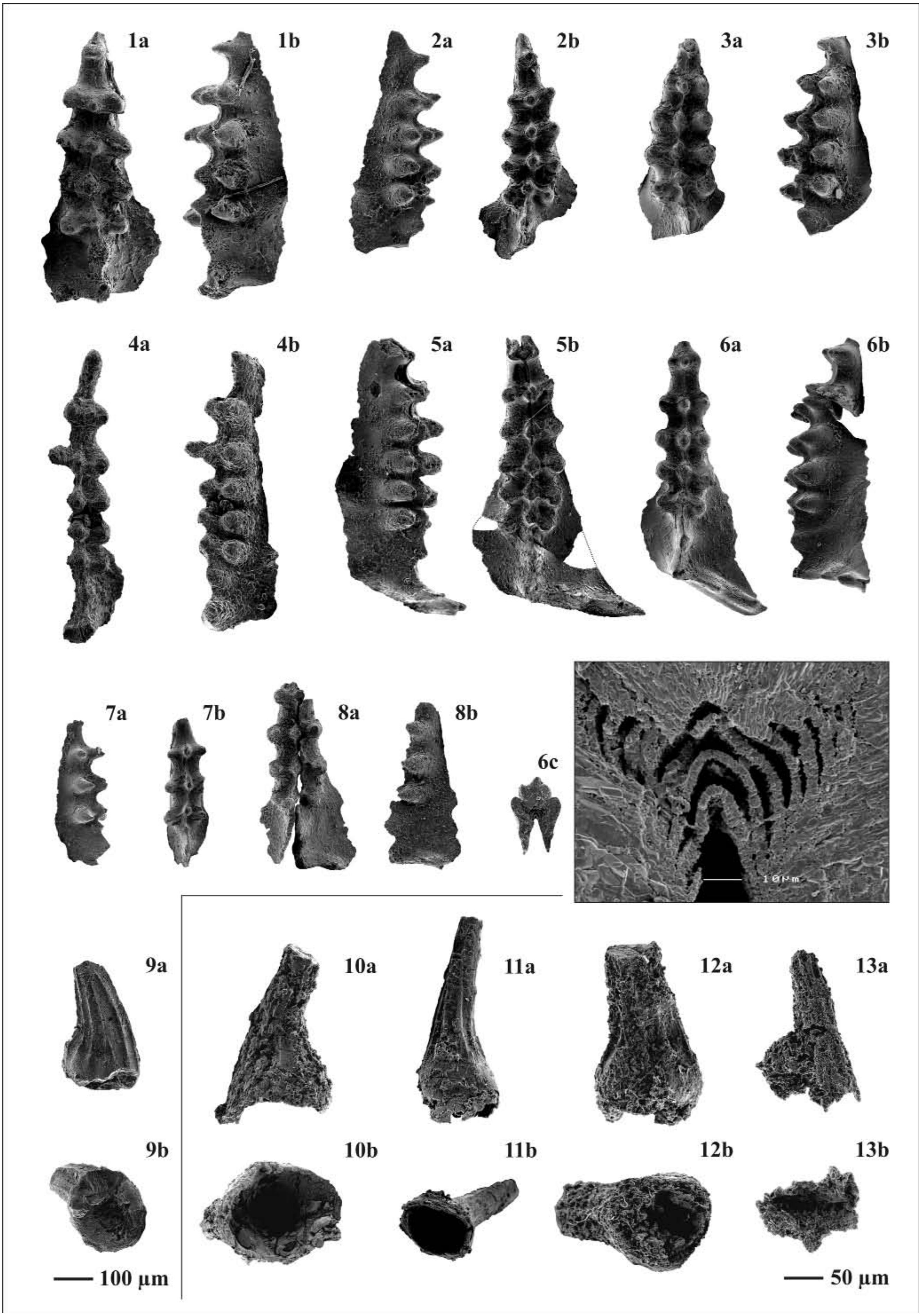
Fig. 9: *Pedavis* sp.
GBA-2006/1/06-19, Se/01/17/04.
Rauchkofel Formation.
M2d element.
a) Lateral view.
b) Lower view.

Fig. 10: *Pedavis* sp.
GBA-2006/1/12-23, Se/02/10/04.
Rauchkofel Formation.
M2d element.
a) Lateral view.
b) Lower view.

Fig. 11: *Pedavis* sp.
GBA-2006/1/14-51, Se/02/10/04.
Rauchkofel Formation.
M2d element.
a) Lateral view.
b) Lower view.

Fig. 12: *Pedavis* sp.
GBA-2006/1/12-25, Se/02/11/04.
Rauchkofel Formation.
M2d element.
a) Lateral view.
b) Lower view.

Fig. 13: *Pedavis* sp.
GBA-2006/1/10-37, Se/02/17/04.
Rauchkofel Formation.
M2b element.
a) Lateral view.
b) Lower view.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100 µm
50 µm

Plate 10

Fig. 1: *Oulodus elegans detorta* (WALLISER, 1964).
GBA-2006/1/14-47, Se/01/02/04.
Megaerella Formation.
M element.
a) Lateral view.
b) Lower view.

Fig. 2: *Oulodus elegans elegans* (WALLISER, 1964).
GBA-2006/1/14-49, Se/01/02/04.
Megaerella Formation.
M element.
a) Lateral view.
b) Lower view.

Fig. 3: *Oulodus elegans elegans* (WALLISER, 1964).
GBA-2006/1/14-48, Se/01/02/04.
Megaerella Formation.
M element.
a) Lateral view.
b) Lower view.

Fig. 4: Unassigned coniform element.
GBA-2006/1/14-50, Se/01/02/04.
Megaerella Formation.
M element.
a) Lateral view.
b) Lower view.

Fig. 5: ? *Oulodus* sp.
GBA-2006/1/12-10, Se/02/01/04.
Rauchkofel Formation.
M element.
a) Lateral view.
b) Lower view.

Fig. 6: *Oulodus* sp.
GBA-2006/1/02-20, Se/01/01/04.
Megaerella Formation.
Sa element.
a) Posterior view.
b) Lateral view.
c) Lower view.

Fig. 7: *Oulodus elegans elegans* (WALLISER, 1964).
GBA-2006/1/14-26, Se/01/03/04.
Megaerella Formation.
Sa element.
a) Lateral view.
b) Lower view.

Fig. 8: *Oulodus elegans detorta* (WALLISER, 1964).
GBA-2006/1/14-46, Se/01/02/04.
Megaerella Formation.
Sa element.
a) Posterior view.
b) Lateral view.
c) Lower view.

Fig. 9: *Oulodus* sp.
GBA-2006/1/11-09, Se/01/04/04.
Megaerella Formation.
Sa element.
a) Posterior view.
b) Lower view.

Fig. 10: *Oulodus* sp.
GBA-2006/1/05-22, Se/01/06a/04.
Rauchkofel Formation.
Sa element.
a) Posterior view.
b) Lower view.

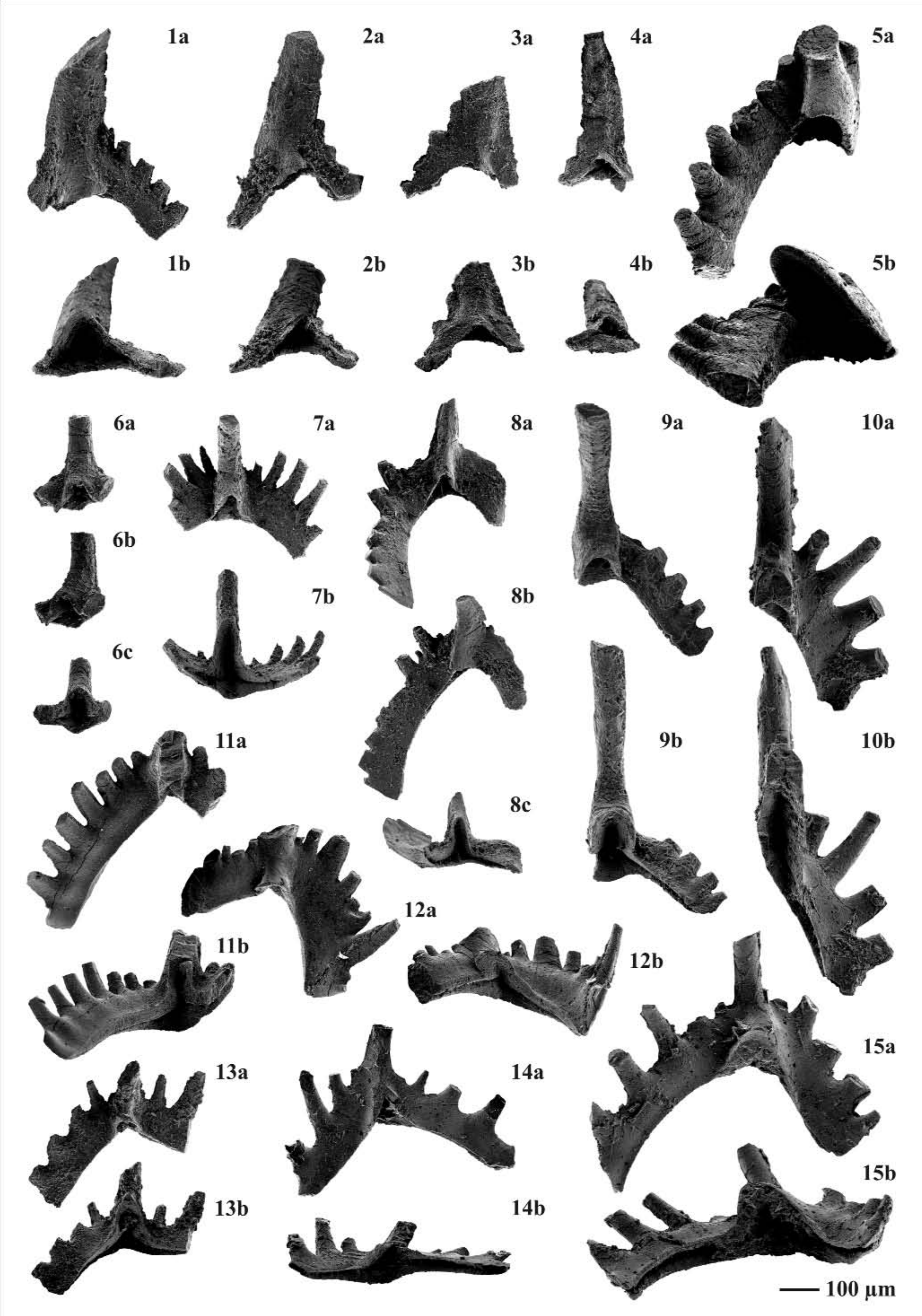
Fig. 11: *Oulodus walliseri* (ZIEGLER, 1960).
GBA-2006/1/07-12, Se/02/02/04.
Rauchkofel Formation.
Sa? element.
a) Posterior view.
b) Lower view.

Fig. 12: *Oulodus aclys* MAWSON, 1986.
GBA-2006/1/07-18, Se/02/02/04.
Rauchkofel Formation.
Sb element.
a) Lateral view.
b) Lower view.

Fig. 13: *Oulodus aclys* MAWSON, 1986.
GBA-2006/1/11-20, Se/01/09/04.
Rauchkofel Formation.
Sb element.
a) Lateral view.
b) Lower view.

Fig. 14: *Oulodus spicula* MAWSON, 1986.
GBA-2006/1/05-18, Se/01/06a/04.
Rauchkofel Formation.
Sb element.
a) Lateral view.
b) Lower view.

Fig. 15: *Oulodus spicula* MAWSON, 1986.
GBA-2006/1/11-06, Se/01/06a/04.
Rauchkofel Formation.
Sb element.
a) Lateral view.
b) Lower view.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13a
14a
15b
13b
14b
100 µm

Plate 11

Fig. 1: *Oulodus spicula* MAWSON, 1986.
GBA-2006/1/07-11, Se/02/02/04.
Rauchkofel Formation.
Pa element.
Lateral view.

Fig. 2: *Oulodus aclys* MAWSON, 1986.
GBA-2006/1/06-12, Se/01/14/04.
Rauchkofel Formation.
Sc element.
a) Posterio-lateral view.
b) Lower view.

Fig. 3: *Oulodus elegans detorta* (WALLISER, 1964).
GBA-2006/1/05-15, Se/01/06a/04.
Rauchkofel Formation.
Sc element.
Lateral view.

Fig. 4: *Oulodus aclys* MAWSON, 1986.
GBA-2006/1/11-12, Se/01/06b/05.
Rauchkofel Formation.
Pa element.
a) Lateral view.
b) Lower view.

Fig. 5: *Oulodus aclys* MAWSON, 1986.
GBA-2006/1/06-17, Se/01/17/04.
Rauchkofel Formation.
Pa element.
a) Lateral view.
b) Lower view.

Fig. 6: *Oulodus* sp. A.
GBA-2006/1/05-23, Se/01/06a/04.
Rauchkofel Formation.
Sb element.
a) Lateral view.
b) Lower view.

Fig. 7: *Oulodus greilingi hirpex* MAWSON, 1986.
GBA-2006/1/11-26, Se/01/06/04.
Rauchkofel Formation.
Pa element.
a) Lateral view.
b) Lower view.

Fig. 8: *Oulodus greilingi hirpex* MAWSON, 1986.
GBA-2006/1/11-07, Se/01/06a/04.
Rauchkofel Formation.
Pa element.
a) Lateral view.
b) Lower view.

Fig. 9: *Oulodus* sp.
GBA-2006/1/14-44, Se/01/05/04.
Megaerella Formation.
Pa element.
a) Lateral view.
b) Lower view.

Fig. 10: *Oulodus walliseri* (ZIEGLER, 1960).
GBA-2006/1/14-45, Se/01/06/04.
Rauchkofel Formation.
Broken posterior process of an M? element.
a) Lateral view.
b) Lower view.

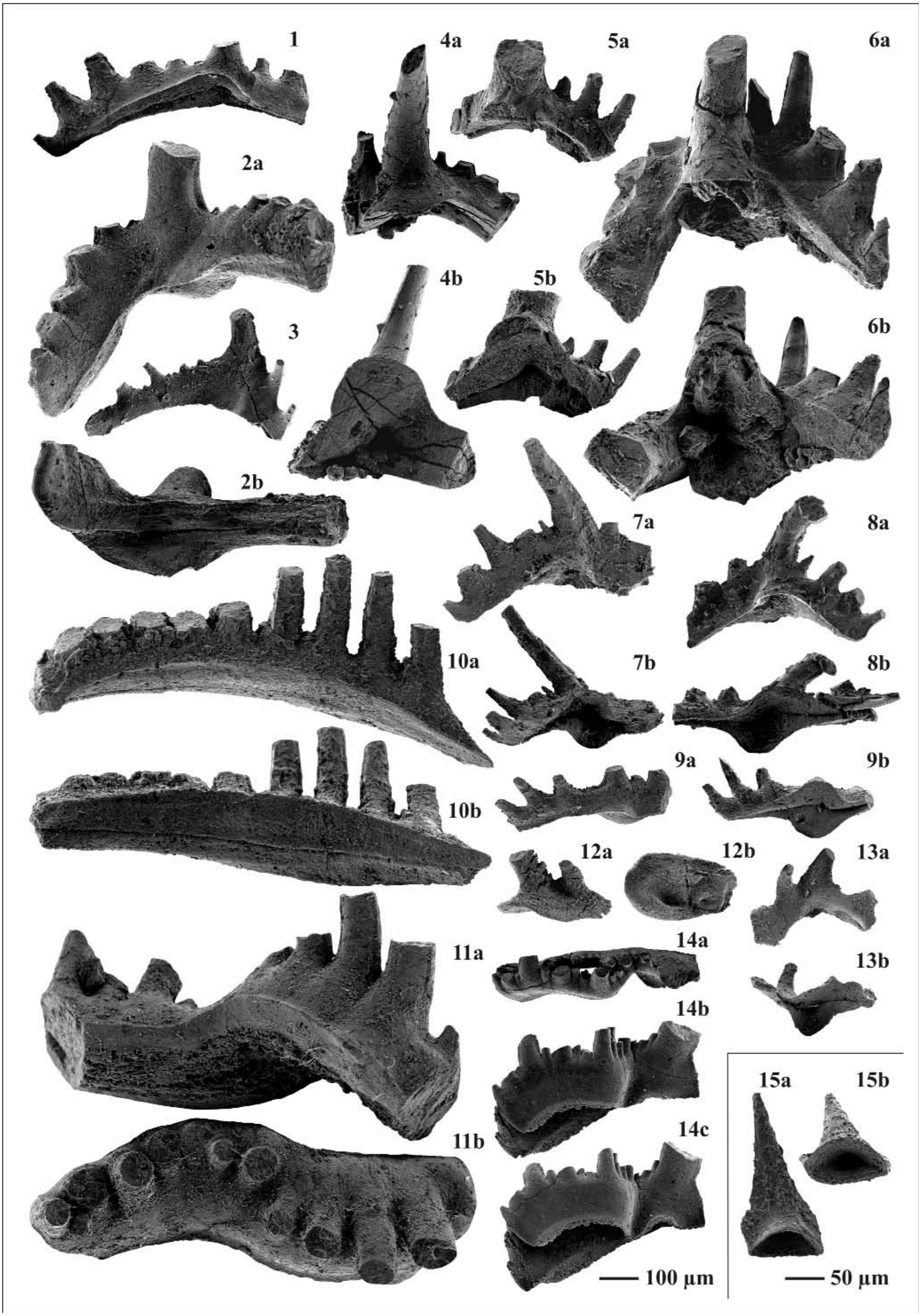
Fig. 11: *Oulodus walliseri* (ZIEGLER, 1960).
GBA-2006/1/07-14, Se/02/02/04.
Rauchkofel Formation.
Pa element.
a) Lateral view.
b) Upper view.

Fig. 12: Unassigned specimen.
GBA-2006/1/14-21, Se/01/01/04.
Megaerella Formation.
Pa element.
a) Lateral view.
b) Lower view.

Fig. 13: Unassigned specimen.
GBA-2006/1/08-07, Se/02/04/04.
Rauchkofel Formation.
a) Lateral view.
b) Lower view.

Fig. 14: Unassigned specimen.
GBA-2006/1/07-26, Se/02/02/04
Rauchkofel Formation.
M element.
a) Upper view.
b) Lateral view.
c) Oblique lower lateral view.

Fig. 15: Pelekysgnathus sp.
GBA-2006/1/16-01, Se/03/20/04.
Hohe Warte Formation.
S element.
a) Lateral view.
b) Lower view.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11b
14c
100 µm
50 µm

Plate 12

Fig. 1: *Ozarkodina excavata excavata* (BRANSON & MEHL, 1933).
GBA-2006/1/02-19, Se/01/01/04.
Megaerella Formation.
M element.
a) Lateral view.
b) Lower view.

Fig. 2: *Ozarkodina excavata* ssp.
GBA-2006/1/07-01, Se/01/16/04.
Rauchkofel Formation.
M element.
Lateral view.

Fig. 3: Unassigned specimen.
GBA-2006/1/10-50, Se/03/40/04.
Hohe Warte Formation.
M element.
a) Lateral view.
b) Lower view.

Fig. 4: Unassigned specimen.
GBA-2006/1/12-32, Se/02/15b/05.
Rauchkofel Formation.
M element.
a) Lateral view.
b) Lower view.

Fig. 5: *Ozarkodina remscheidensis remscheidensis* (ZIEGLER, 1960).
GBA-2006/1/04-32, Se/01/06a/04.
Rauchkofel Formation.
M element.
a) Lateral view.
b) Lower view.

Fig. 6: *Ozarkodina remscheidensis remscheidensis* (ZIEGLER, 1960).
GBA-2006/1/07-06, Se/01/16/04.
Rauchkofel Formation.
M element.
a) Lateral view.
b) Lower view.

Fig. 7: *Ozarkodina excavata excavata* (BRANSON & MEHL, 1933).
GBA-2006/1/01-15, Se/01/01/04.
Megaerella Formation.
Sa element.
a) Posterior view.
b) Lower view.

Fig. 8: *Ozarkodina remscheidensis remscheidensis* (ZIEGLER, 1960).
GBA-2006/1/05-02, Se/01/06a/04.
Rauchkofel Formation.
Sa element.
a) Posterior view.
b) Lower view.

Fig. 9: *Ozarkodina* aff. *O. excavata tuma* MURPHY & MATTI, 1983).
GBA-2006/1/04-22, Se/01/06a/04.
Rauchkofel Formation.
Sa element.
a) Posterior view.
b) Lower view.

Fig. 10: *Ozarkodina* aff. *O. excavata tuma* MURPHY & MATTI, 1983).
GBA-2006/1/01-13, Se/01/01/04.
Megaerella Formation.
Sa element.
a) Posterior view.
b) Lower view.

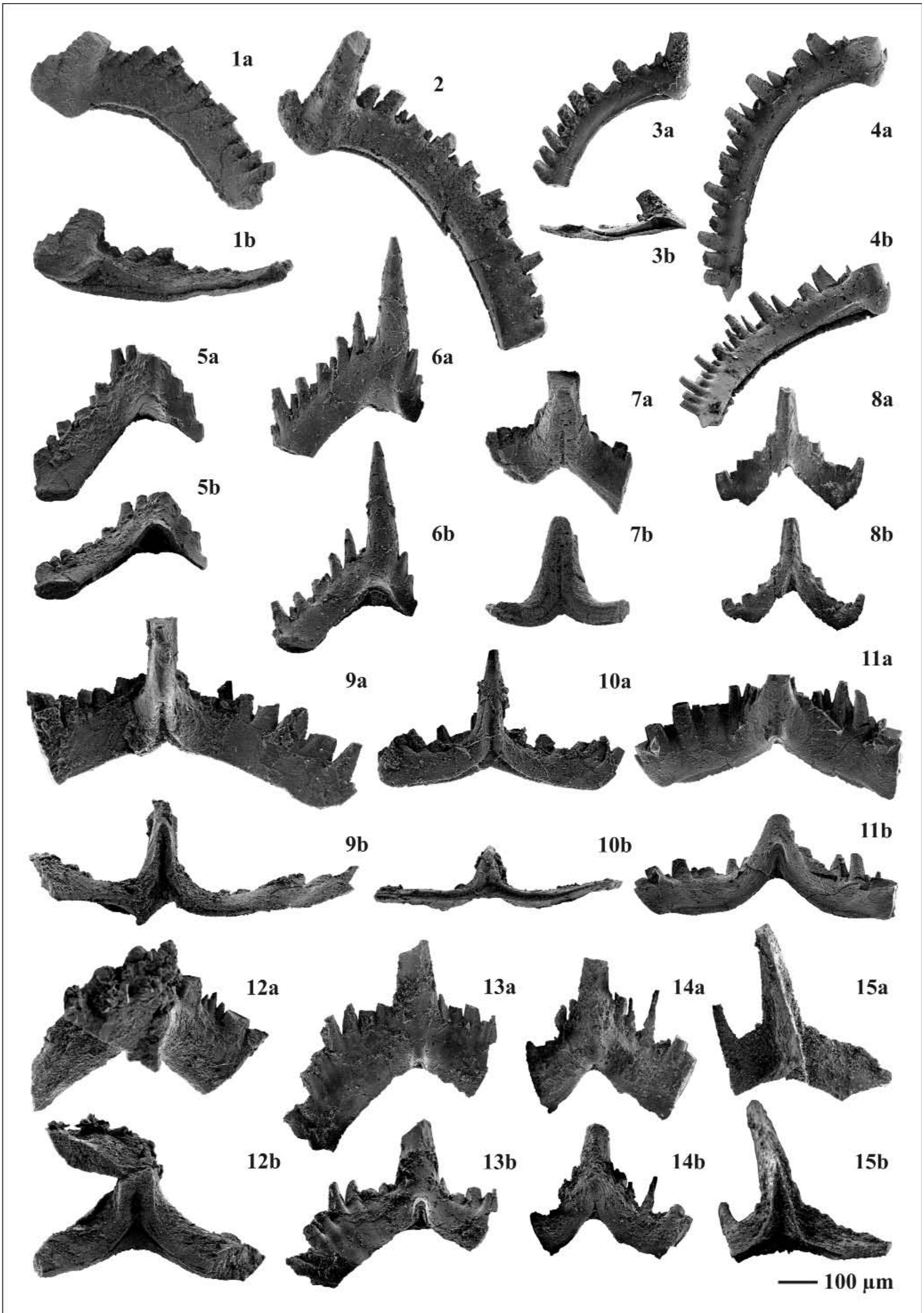
Fig. 11: *Ozarkodina* cf. *O. remscheidensis* ssp.
GBA-2006/1/06-02, Se/01/07/04.
Rauchkofel Formation.
Sa element.
a) Posterior view.
b) Lower view.

Fig. 12: *Pandorinellina* sp.
GBA-2006/1/14-52, Se/01/05b/05.
Rauchkofel Formation.
Sa element (attached on posterior processus a fragmented Pa element).
a) Posterior view.
b) Lower view.

Fig. 13: Unassigned specimen.
GBA-2006/1/07-24, Se/02/02/04.
Rauchkofel Formation.
Sa element.
a) Posterior view.
b) Lower view.

Fig. 14: Unassigned specimen.
GBA-2006/1/13-11, Se/03/18/04.
Hohe Warte Formation.
Sa element.
a) Posterior view.
b) Lower view.

Fig. 15: Unassigned specimen.
GBA-2006/1/14-37, Se/01/15/04.
Rauchkofel Formation.
Sb element.
a) Lateral view.
b) Lower view.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12a
12b
13a
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14a
14b
15a
15b
100 µm

Plate 13

Fig. 1: *Ozarkodina* aff. *O. excavata tuma* MURPHY & MATTI, 1983.
GBA-2006/1/04-26, Se/01/06a/04.
Rauchkofel Formation.
Sb element.
a) Lateral view.
b) Lower view.

Fig. 2: *Ozarkodina* aff. *O. excavata tuma* MURPHY & MATTI, 1983.
GBA-2006/1/04-30, Se/01/06a/04.
Rauchkofel Formation.
Sb element.
a) Lateral view.
b) Lower view.

Fig. 3: *Ozarkodina excavata excavata* (BRANSON & MEHL, 1933).
GBA-2006/1/04-23, Se/01/06a/04.
Rauchkofel Formation.
Sb element.
a) Lateral view.
b) Lower view.

Fig. 4: Unassigned specimen.
GBA-2006/1/13-26, Se/04/-11/04.
Hohe Warte Formation.
Sb element.
a) Lateral view.
b) Lower view.

Fig. 5: *Ozarkodina excavata excavata* (BRANSON & MEHL, 1933).
GBA-2006/1/06-04, Se/01/07/04.
Rauchkofel Formation.
Sb element.
a) Lateral view.
b) Lower view.

Fig. 6: Unassigned specimen.
GBA-2006/1/02-02, Se/01/01/04.
Megaerella Formation.
Sb element.
a) Lateral view.
b) Lower view.

Fig. 7: Unassigned specimen.
GBA-2006/1/09-04, Se/03/27/04.
Hohe Warte Formation.
Sb? element.
a) Posterior view.
b) Lower view.

Fig. 8: *Ozarkodina excavata excavata* (BRANSON & MEHL, 1933).
GBA-2006/1/02-15, Se/01/01/04.
Megaerella Formation.
Sc element.
a) Lateral view.
b) Lower view.

Fig. 9: *Ozarkodina excavata excavata* (BRANSON & MEHL, 1933).
GBA-2006/1/02-21, Se/01/01/04.
Megaerella Formation.
Sc element.
a) Lateral view.
b) Lower view.

Fig. 10: Unassigned specimen.
GBA-2006/1/09-18, Se/04/-11/04.
Hohe Warte Formation.
Sc element.
a) Lateral view.
b) Lower view.

Fig. 11: Unassigned specimen.
GBA-2006/1/13-12, Se/03/18/04.
Hohe Warte Formation.
Sc element.
Lateral view.

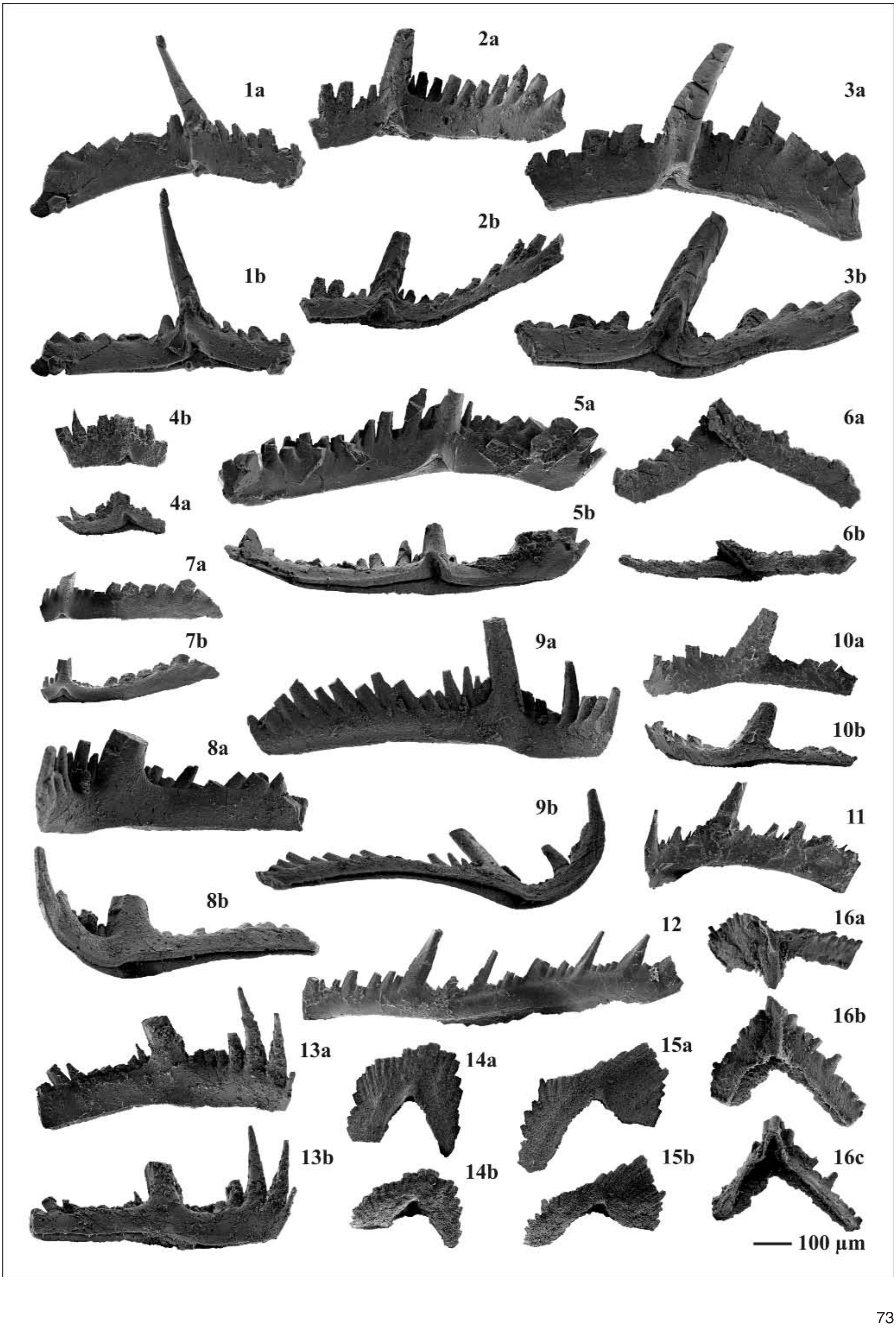
Fig. 12: Unassigned specimen.
GBA-2006/1/09-24, Se/03/19/04.
Hohe Warte Formation.
Sc element.
Lateral view.

Fig. 13: *Ozarkodina* aff. *O. excavata tuma* MURPHY & MATTI, 1983.
GBA-2006/1/04-24, Se/01/06a/04.
Rauchkofel Formation.
Sc element.
a) Lateral view.
b) Lower view.

Fig. 14: ‘Apparatus A’ MASTANDREA, 1985a.
GBA-2006/1/12-01, Se/01/16/04.
Rauchkofel Formation.
Sb? element.
a) Lateral view.
b) Lower view.

Fig. 15: ‘Apparatus A’ MASTANDREA, 1985a.
GBA-2006/1/12-02, Se/01/16/04.
Rauchkofel Formation.
Sc? element.
a) Lateral view.
b) Lower view.

Fig. 16: ‘Apparatus A’ MASTANDREA, 1985a.
GBA-2006/1/07-03, Se/01/16/04.
Rauchkofel Formation.
M element.
a) Upper view.
b) Posterior view.
c) Lower view.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13a
14a
15a
13b
14b
15b
16c
100 µm

Plate 14

Fig. 1: 'Apparatus A' MASTANDREA, 1985a.
GBA-2006/1/07-02, Se/01/16/04.
Rauchkofel Formation.
M element.
a) Posterior view.
b) Lower view.

Fig. 2: *Ozarkodina excavata excavata* (BRANSON & MEHL, 1933).
GBA-2006/1/01-18, Se/01/01/04.
Megaerella Formation.
Cluster of a broken M & Pa element.
a) Lateral view.
b) Lower view.

Fig. 3: *Ozarkodina excavata excavata* (BRANSON & MEHL, 1933).
GBA-2006/1/01-23, Se/01/01/04.
Megaerella Formation.
Pb element.
a) Lateral view.
b) Lower view.

Fig. 4: *Ozarkodina excavata excavata* (BRANSON & MEHL, 1933).
GBA-2006/1/05-27, Se/01/06a/04.
Rauchkofel Formation.
Pb element.
a) Lateral view.
b) Lower view.

Fig. 5: *Ozarkodina excavata excavata* (BRANSON & MEHL, 1933).
GBA-2006/1/01-16, Se/01/01/04.
Megaerella Formation.
Pb element.
a) Lateral view.
b) Lower view.

Fig. 6: *Ozarkodina excavata excavata* (BRANSON & MEHL, 1933).
GBA-2006/1/11-28, Se/01/06/04.
Rauchkofel Formation.
Pb element.
a) Lateral view.
b) Lower view.

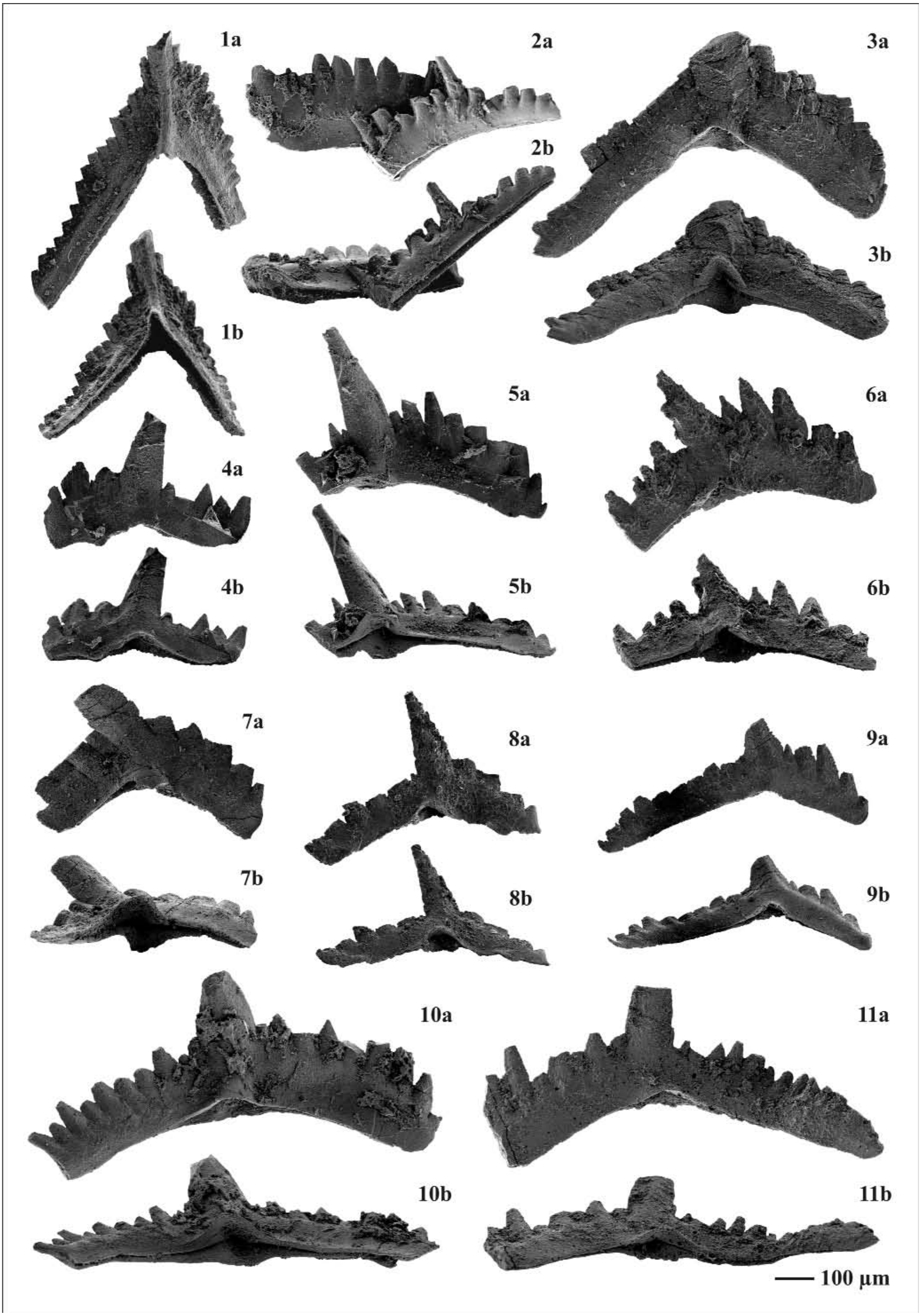
Fig. 7: *Ozarkodina excavata excavata* (BRANSON & MEHL, 1933).
GBA-2006/1/12-08, Se/02/01/04.
Rauchkofel Formation.
Pb element.
a) Lateral view.
b) Lower view.

Fig. 8: *Ozarkodina excavata excavata* (BRANSON & MEHL, 1933).
GBA-2006/1/05-30, Se/01/06a/04.
Rauchkofel Formation.
Pb element.
a) Lateral view.
b) Lower view.

Fig. 9: *Ozarkodina excavata excavata* (BRANSON & MEHL, 1933).
GBA-2006/1/07-22, Se/02/02/04.
Rauchkofel Formation.
Pb element.
a) Lateral view.
b) Lower view.

Fig. 10: *Ozarkodina excavata excavata* (BRANSON & MEHL, 1933).
GBA-2006/1/02-01, Se/01/01/04.
Megaerella Formation.
Pb element.
a) Lateral view.
b) Lower view.

Fig. 11: *Ozarkodina excavata excavata* (BRANSON & MEHL, 1933).
GBA-2006/1/02-04, Se/01/01/04.
Megaerella Formation.
Pb element.
a) Lateral view.
b) Lower view.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11a
10b
11b
100 µm

Plate 15

Fig. 1: *Ozarkodina* cf. *O. remscheidensis* ssp.
GBA-2006/1/05-25, Se/01/06a/04.
Rauchkofel Formation.
Pb element.
a) Lateral view.
b) Lower view.

Fig. 2: *Ozarkodina* cf. *O. remscheidensis* ssp.
GBA-2006/1/11-11, Se/01/06b/05.
Rauchkofel Formation.
Pb element.
a) Lateral view.
b) Lower view.

Fig. 3: Unassigned specimen.
GBA-2006/1/11-21, Se/01/06/04.
Rauchkofel Formation.
Pb element.
a) Lateral view.
b) Lower view.

Fig. 4: Unassigned specimen.
GBA-2006/1/11-15, Se/01/08/04.
Rauchkofel Formation.
Pb element.
a) Lateral view.
b) Lower view.

Fig. 5: *Ozarkodina* cf. *O. remscheidensis* ssp.
GBA-2006/1/12-29, Se/01/07/04.
Rauchkofel Formation.
Pb element.
a) Lateral view.
b) Lower view.

Fig. 6: Unassigned specimen.
GBA-2006/1/11-16, Se/01/08/04.
Rauchkofel Formation.
Pb element.
a) Lateral view.
b) Lower view.

Fig. 7: Unassigned specimen.
GBA-2006/1/08-08, Se/02/04/04.
Rauchkofel Formation.
Pb element.
a) Lateral view.
b) Lower view.

Fig. 8: Unassigned specimen.
GBA-2006/1/11-13, Se/01/08/04.
Rauchkofel Formation.
Pb element.
a) Lateral view.
b) Lower view.

Fig. 9: Unassigned specimen.
GBA-2006/1/07-27, Se/02/04/04.
Rauchkofel Formation.
Pb element.
a) Lateral view.
b) Lower view.

Fig. 10: Unassigned specimen.
GBA-2006/1/10-44, Se/03/17/04.
Hohe Warte Formation.
Pb element.
a) Lateral view.
b) Lower view.

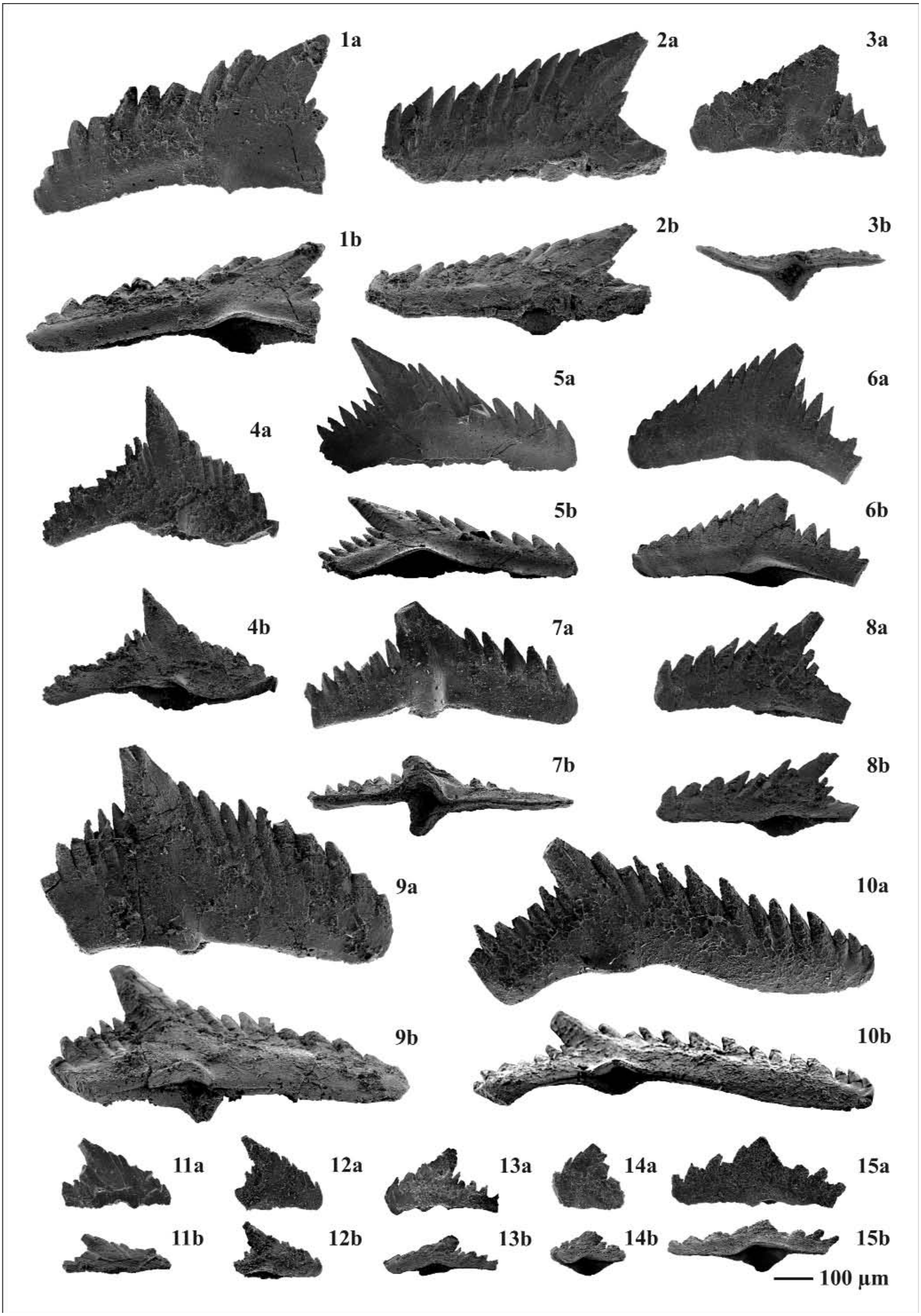
Fig. 11: *Flajsella* sp.
GBA-2006/1/11-02, Se/01/11/04.
Rauchkofel Formation.
Pb element.
a) Lateral view.
b) Lower view.

Fig. 12: *Flajsella* sp.
GBA-2006/1/14-39, Se/01/16/04.
Rauchkofel Formation.
Pb element.
a) Lateral view.
b) Lower view.

Fig. 13: Unassigned specimen.
GBA-2006/1/13-13, Se/03/19/04.
Hohe Warte Formation.
Pb element.
a) Lateral view.
b) Lower view.

Fig. 14: Unassigned specimen.
GBA-2006/1/14-05, Se/04/-11/04.
Hohe Warte Formation.
Pb element.
a) Lateral view.
b) Lower view.

Fig. 15: Unassigned specimen.
GBA-2006/1/09-35, Se/04/08/04.
Hohe Warte Formation.
Pb element.
a) Lateral view.
b) Lower view.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15b
100 µm

Plate 16

Fig. 1: *Ozarkodina excavata excavata* (BRANSON & MEHL, 1933).
GBA-2006/1/03-07, Se/01/01/04.
Megaerella Formation.
Pa element.
a) Lateral view.
b) Upper view.

Fig. 2: *Ozarkodina excavata excavata* (BRANSON & MEHL, 1933).
GBA-2006/1/03-09, Se/01/01/04.
Megaerella Formation.
Pa element.
a) Lateral view.
b) Lower view.

Fig. 3: *Ozarkodina excavata excavata* (BRANSON & MEHL, 1933).
GBA-2006/1/02-35, Se/01/01/04.
Megaerella Formation.
Pa element.
a) Lateral view.
b) Lower view.

Fig. 4: *Ozarkodina excavata excavata* (BRANSON & MEHL, 1933).
GBA-2006/1/03-08, Se/01/01/04.
Megaerella Formation.
Pa element.
a) Lateral view.
b) Lower view.

Fig. 5: *Ozarkodina excavata excavata* (BRANSON & MEHL, 1933).
GBA-2006/1/02-30, Se/01/01/04.
Megaerella Formation.
Pa element.
a) Lateral view.
b) Lower view.

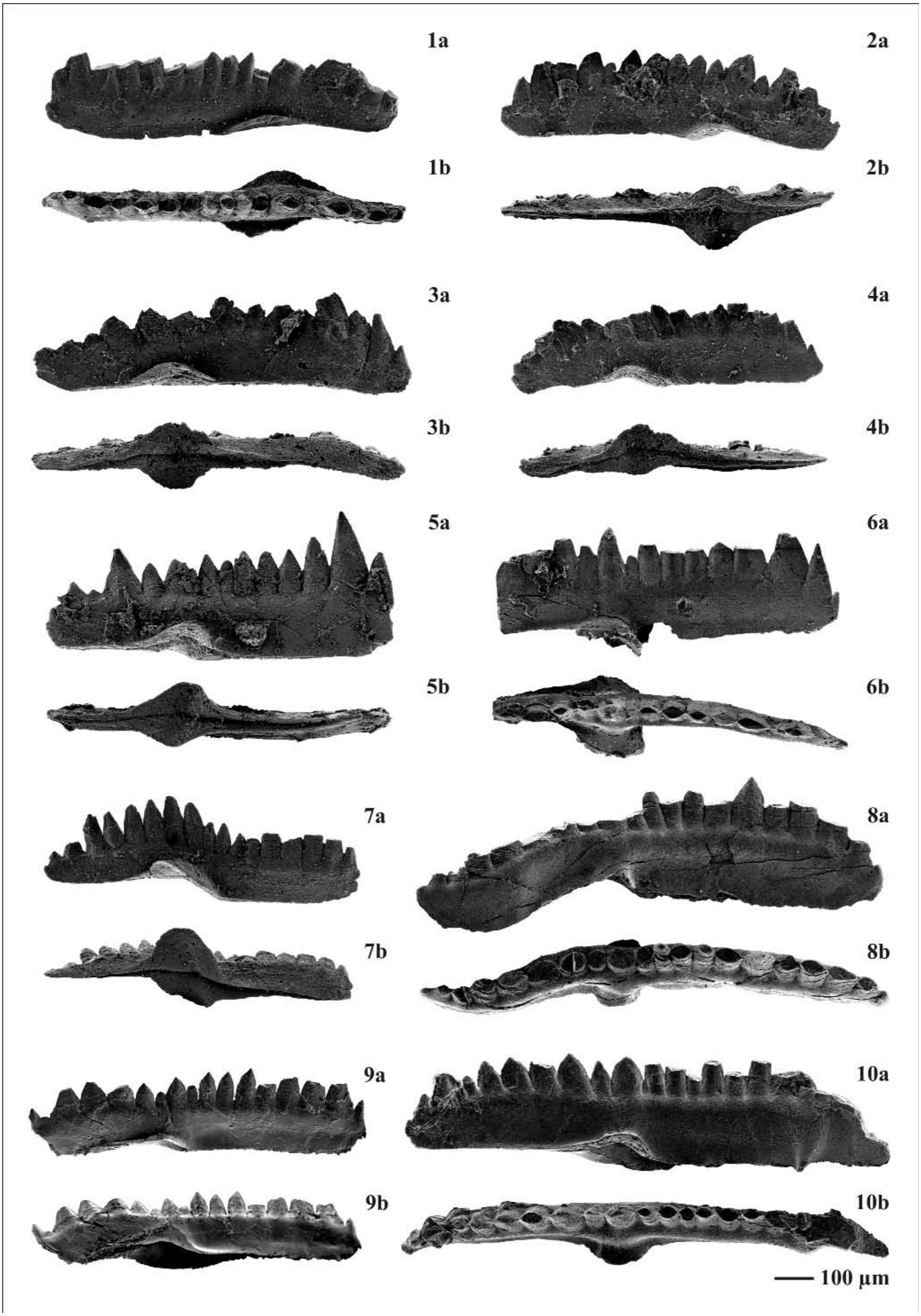
Fig. 6: *Ozarkodina excavata excavata* (BRANSON & MEHL, 1933).
GBA-2006/1/04-15, Se/01/06a/04.
Rauchkofel Formation.
Pa element.
a) Lateral view.
b) Upper view.

Fig. 7: *Ozarkodina excavata excavata* (BRANSON & MEHL, 1933).
GBA-2006/1/02-33, Se/01/01/04.
Megaerella Formation.
Pa element.
a) Lateral view.
b) Lower view.

Fig. 8: *Ozarkodina* aff. *O. excavata tuma* MURPHY & MATTI, 1983.
GBA-2006/1/17-04, Se/01/14/04.
Rauchkofel Formation.
Pa element.
a) Lateral view.
b) Upper view.

Fig. 9: *Ozarkodina excavata excavata* (BRANSON & MEHL, 1933).
GBA-2006/1/09-05, Se/03/27/04.
Hohe Warte Formation.
Pa element.
a) Lateral view.
b) Lower view.

Fig. 10: *Ozarkodina* aff. *O. excavata tuma* MURPHY & MATTI, 1983.
GBA-2006/1/13-22, Se/03/31/04.
Hohe Warte Formation.
Pa element.
a) Lateral view.
b) Upper view.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10b
100 µm

Plate 17

Fig. 1: *Ozarkodina excavata excavata* (Branson & Mehl, 1933).
GBA-2006/1/04-10, Se/01/06a/04.
Rauchkofel Formation.
Pa element.
a) Lateral view.
b) Upper view.

Fig. 2: *Ozarkodina excavata excavata* (Branson & Mehl, 1933).
GBA-2006/1/12-30, Se/01/07/04.
Rauchkofel Formation.
Pa element.
a) Lateral view.
b) Upper view.

Fig. 3: *Ozarkodina excavata excavata* (Branson & Mehl, 1933).
GBA-2006/1/07-23, Se/02/02/04.
Rauchkofel Formation.
Pa element.
a) Lateral view.
b) Upper view.

Fig. 4: *Ozarkodina wurmi* (Bischoff & Sannemann, 1958).
GBA-2006/1/17-03, Se/01/06/04.
Rauchkofel Formation
Pa element.
a) Lateral view.
b) Lower view.

Fig. 5: *Ozarkodina excavata excavata* (Branson & Mehl, 1933).
GBA-2006/1/10-07, Se/02/02/04.
Rauchkofel Formation.
Pa element.
a) Lateral view.
b) Lower view.

Fig. 6: *Ozarkodina remscheidensis remscheidensis* (Ziegler, 1960).
GBA-2006/1/03-13, Se/01/01/04.
Megaerella Formation.
Pa element.
a) Lateral view.
b) Lower view.

Fig. 7: *Ozarkodina remscheidensis remscheidensis* (Ziegler, 1960).
GBA-2006/1/04-19, Se/01/06a/04.
Rauchkofel Formation.
Pa element.
a) Lateral view.
b) Upper view.

Fig. 8: *Ozarkodina remscheidensis remscheidensis* (Ziegler, 1960).
GBA-2006/1/04-17, Se/01/06a/04.
Rauchkofel Formation.
Pa element.
a) Lateral view.
b) Upper view.

Fig. 9: *Ozarkodina remscheidensis remscheidensis* (Ziegler, 1960).
GBA-2006/1/11-24, Se/01/06/04.
Rauchkofel Formation.
Pa element.
a) Lateral view.
b) Lower view.

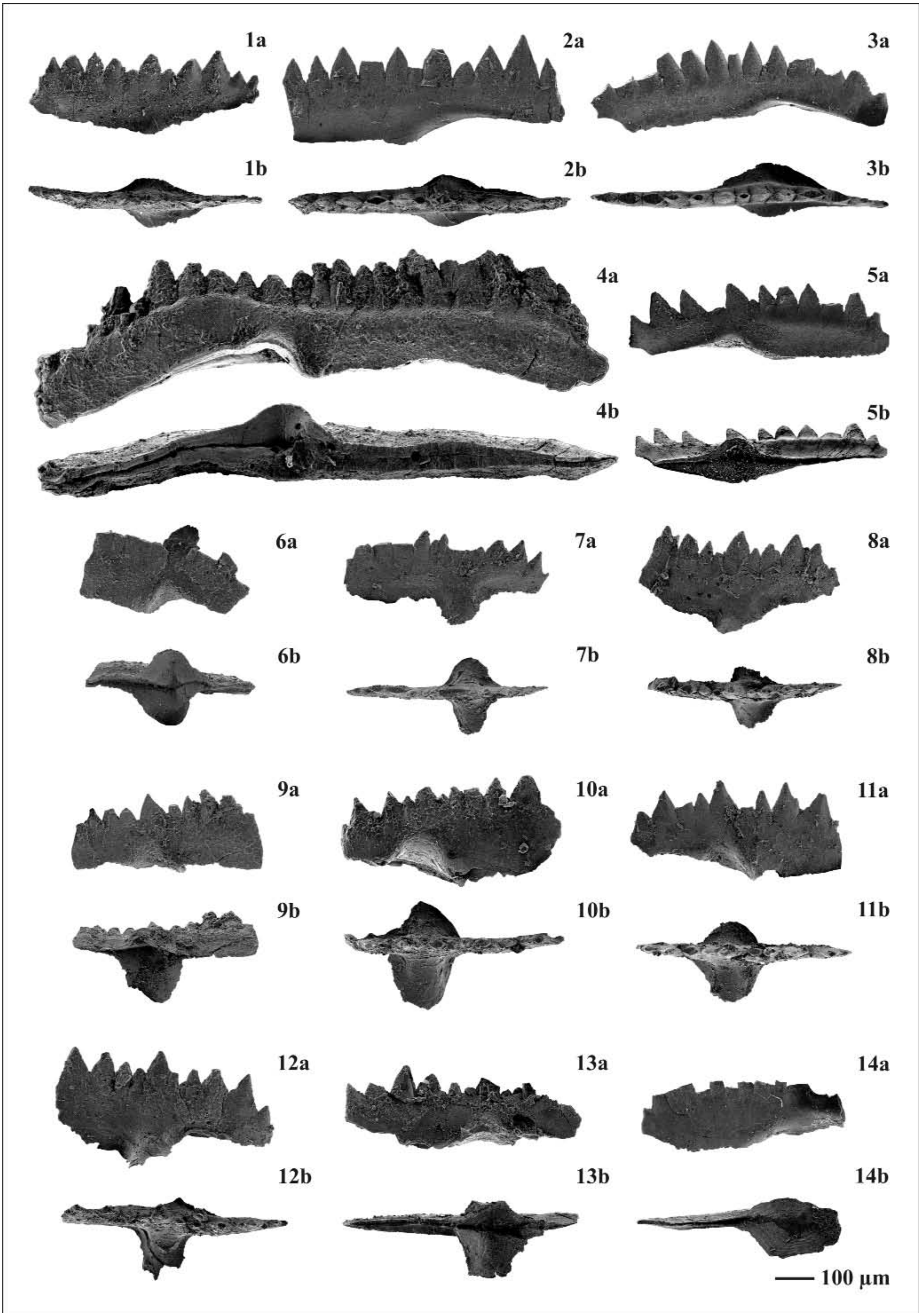
Fig. 10: *Ozarkodina remscheidensis remscheidensis* (Ziegler, 1960).
GBA-2006/1/05-06, Se/01/06a/04.
Rauchkofel Formation.
Pa element.
a) Lateral view.
b) Upper view.

Fig. 11: *Ozarkodina remscheidensis remscheidensis* (Ziegler, 1960).
GBA-2006/1/05-11, Se/01/06a/04.
Rauchkofel Formation.
Pa element.
a) Lateral view.
b) Upper view.

Fig. 12: *Ozarkodina remscheidensis remscheidensis* (Ziegler, 1960).
GBA-2006/1/04-11, Se/01/06a/04.
Rauchkofel Formation.
Pa element.
a) Lateral view.
b) Upper view.

Fig. 13: *Ozarkodina remscheidensis remscheidensis* (Ziegler, 1960).
GBA-2006/1/04-14, Se/01/06a/04.
Rauchkofel Formation.
Pa element.
a) Lateral view.
b) Lower view.

Fig. 14: Unassigned specimen.
GBA-2006/1/06-08, Se/01/13/04.
Rauchkofel Formation.
Pa element.
a) Lateral view.
b) Lower view.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14b
100 µm

Plate 18

Fig. 1: *Ozarkodina remscheidensis remscheidensis* (ZIEGLER, 1960).
GBA-2006/1/10-01, Se/01/08/04.
Rauchkofel Formation.
Pa element.
a) Lateral view.
b) Lower view.

Fig. 2: *Ozarkodina* aff. *O. remscheidensis eosteinhornensis* (WALLISER, 1964) beta morph MURPHY, VALENZUELA-RÍOS & CARLS, 2004.
GBA-2006/1/11-14, Se/01/08/04.
Rauchkofel Formation.
Pa element.
a) Lateral view.
b) Lower view.

Fig. 3: Unassigned specimen.
GBA-2006/1/10-02, Se/01/08/04.
Rauchkofel Formation.
Pa element.
a) Lateral view.
b) Lower view.

Fig. 4: *Ozarkodina* cf. *O. remscheidensis* ssp.
GBA-2006/1/08-04, Se/02/04/04.
Rauchkofel Formation.
Pa element.
a) Lateral view.
b) Upper view.

Fig. 5: *Ozarkodina camelfordensis* FARRELL, 2004.
GBA-2006/1/11-22, Se/01/06/04.
Rauchkofel Formation.
Pa element.
a) Lateral view.
b) Lower view.

Fig. 6: Unassigned specimen.
GBA-2006/1/12-31, Se/01/07/04.
Rauchkofel Formation.
Pa element.
a) Anterior view.
b) Upper view.

Fig. 7: *Ozarkodina* cf. *O. remscheidensis* ssp.
GBA-2006/1/06-21, Se/01/17/04.
Rauchkofel Formation.
Pa element.
a) Lateral view.
b) Lower view.

Fig. 8: *Ozarkodina* cf. *O. remscheidensis* ssp.
GBA-2006/1/07-25, Se/02/02/04.
Rauchkofel Formation.
Pa element.
a) Lateral view.
b) Upper view.

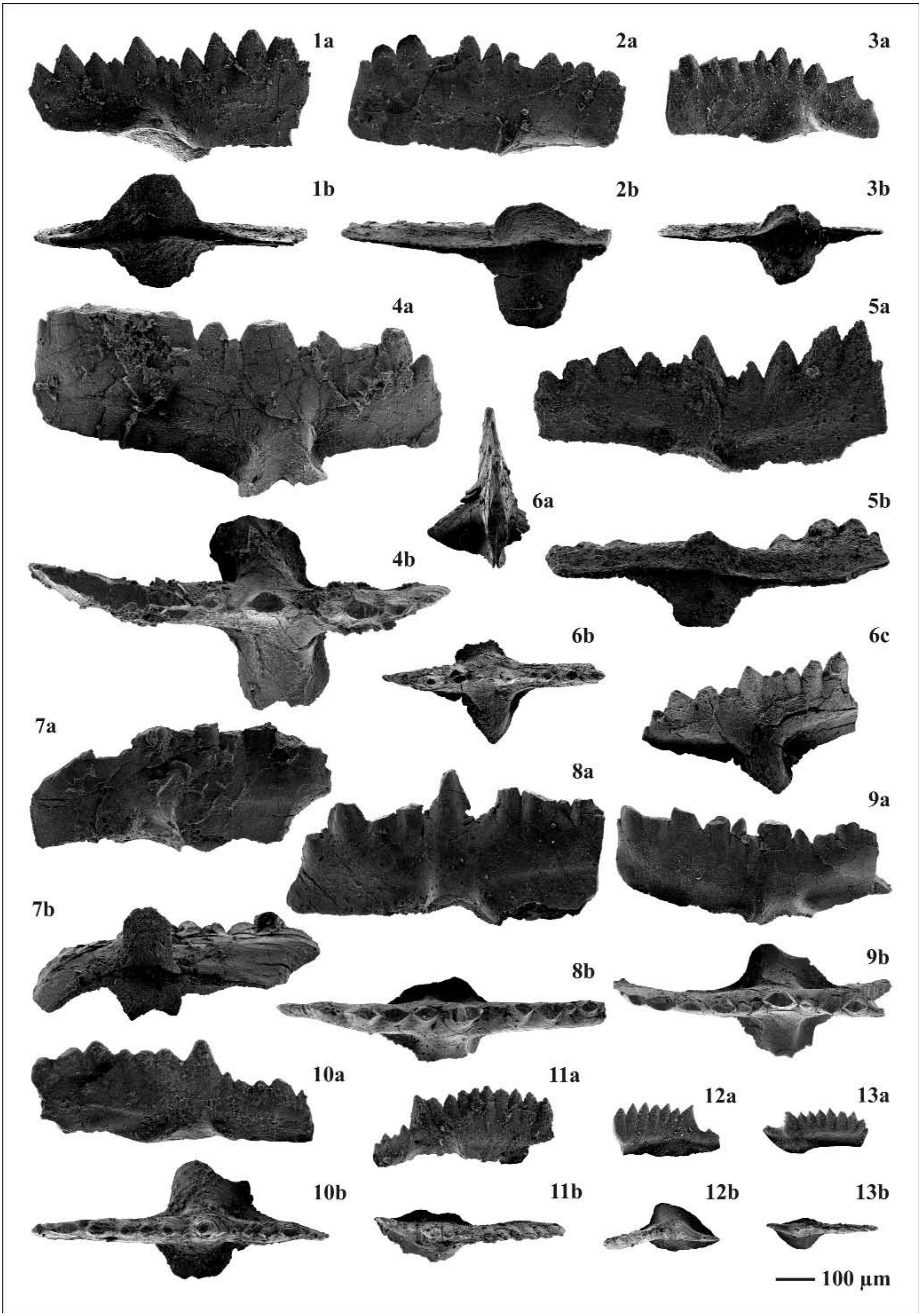
Fig. 9: *Ozarkodina* cf. *O. remscheidensis* ssp.
GBA-2006/1/06-22, Se/01/17/04
Rauchkofel Formation.
Pa element.
a) Lateral view.
b) Upper view.

Fig. 10: *Ozarkodina* aff. *O. paucidentata* MURPHY & MATTI, 1983.
GBA-2006/1/07-07, Se/01/16/04.
Rauchkofel Formation
Pa element.
a) Lateral view.
b) Upper view.

Fig. 11: *Flajsella schulzei* (BARDASHEV, 1989).
GBA-2006/1/12-03, Se/01/16/04.
Rauchkofel Formation.
Pa element.
a) Lateral view.
b) Upper view.

Fig. 12: *Flajsella stygia* (FLAJS, 1967).
GBA-2006/1/14-41, Se/01/16/04.
Rauchkofel Formation.
Pa element.
a) Lateral view.
b) Upper view.

Fig. 13: *Flajsella stygia* (FLAJS, 1967).
GBA-2006/1/12-04, Se/01/16/04.
Rauchkofel Formation.
Pa element.
a) Lateral view.
b) Upper view.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13b
100 µm

Plate 19

Fig. 1: *Ozarkodina pandora* alpha morph MURPHY, MATTI & WALLISER, 1981.
GBA-2006/1/12-33, Se/02/06a/05.
Rauchkofel Formation.
Pa element.
a) Lateral view.
b) Upper view.
c) Anterior view.

Fig. 2: *Ozarkodina pandora* alpha morph MURPHY, MATTI & WALLISER, 1981.
GBA-2006/1/14-40, Se/01/16/04.
Rauchkofel Formation.
Pa element.
a) Lateral view.
b) Upper view.

Fig. 3: *Ozarkodina pandora* alpha morph MURPHY, MATTI & WALLISER, 1981.
GBA-2006/1/12-06, Se/01/17/04.
Rauchkofel Formation.
Pa element.
a) Lateral view.
b) Upper view.

Fig. 4: Unassigned specimen.
GBA-2006/1/10-49, Se/03/40/04.
Hohe Warte Formation.
Pa element.
a) Lateral view.
b) Upper view.

Fig. 5: *Lanea omoalpha* MURPHY & VALENZUELA-RÍOS, 1999.
GBA-2006/1/11-03, Se/01/07/04.
Rauchkofel Formation
Pa element.
a) Lateral view.
b) Lower view.

Fig. 6: Unassigned specimen.
GBA-2006/1/12-28, Se/02/12/04.
Rauchkofel Formation.
Pa element.
a) Lateral view.
b) Upper view.

Fig. 7: *Ozarkodina remscheidensis repetitor* (CARLS & GANDL, 1969).
GBA-2006/1/13-25, Se/04/-11/04.
Hohe Warte Formation.
Pa element.
a) Lateral view.
b) Upper view.

Fig. 8: *Lanea omoalpha* MURPHY & VALENZUELA-RÍOS, 1999.
GBA-2006/1/14-36, Se/01/15/04.
Rauchkofel Formation.
Pa element.
a) Lateral view.
b) Upper view.

Fig. 9: *Ozarkodina remscheidensis repetitor* (CARLS & GANDL, 1969).
GBA-2006/1/13-29, Se/04/-11/04.
Hohe Warte Formation.
Pa element.
a) Lateral view.
b) Lower view.

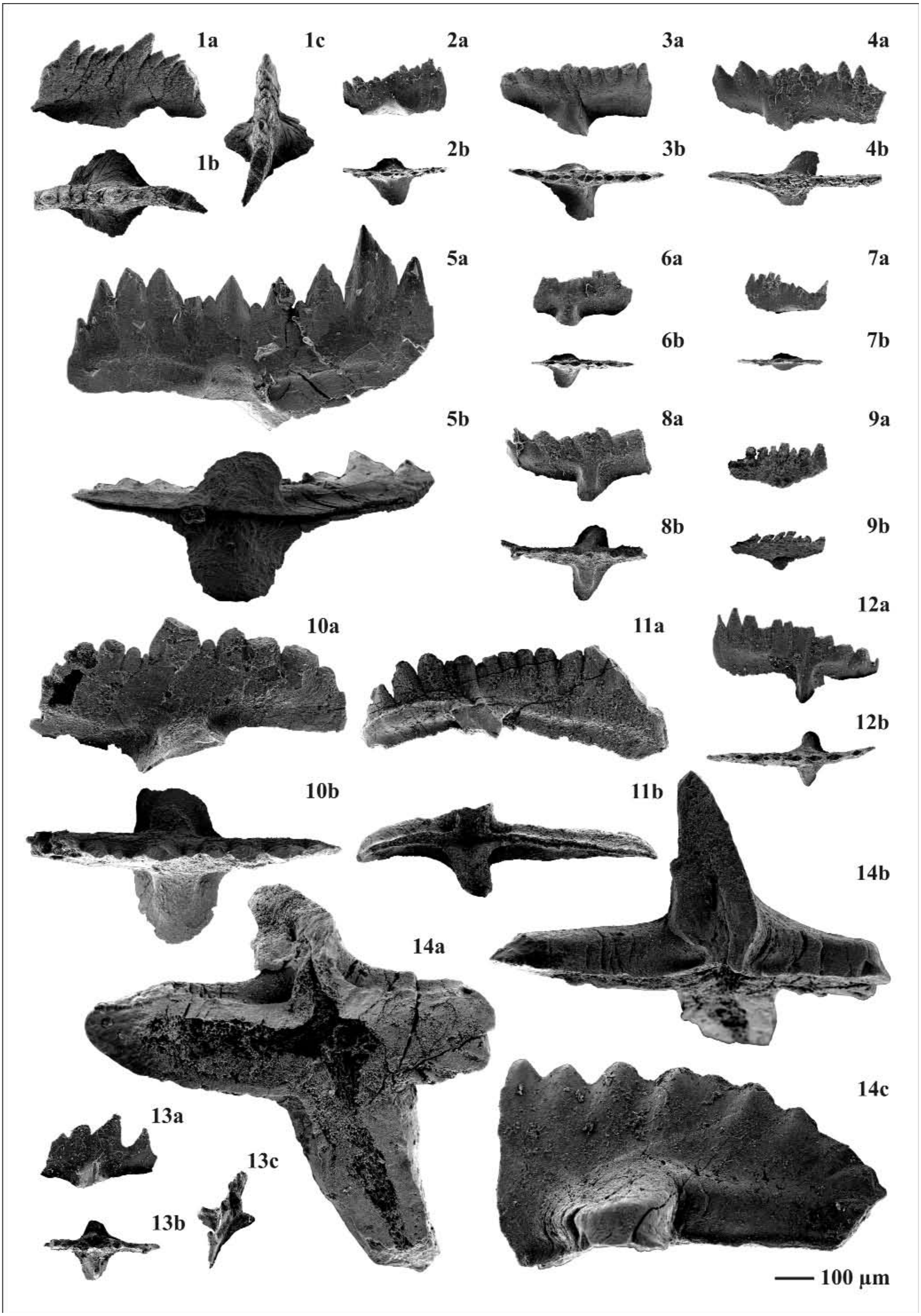
Fig. 10: *Lanea omoalpha* MURPHY & VALENZUELA-RÍOS, 1999.
GBA-2006/1/14-35, Se/01/08/04.
Rauchkofel Formation.
Pa element.
a) Lateral view.
b) Upper view.

Fig. 11: *Lanea telleri* (SCHULZE, 1968).
GBA-2006/1/12-09, Se/02/01/04.
Rauchkofel Formation.
Pa element.
a) Lateral view.
b) Lower view.

Fig. 12: *Lanea telleri* (SCHULZE, 1968).
GBA-2006/1/12-05, Se/01/16/04.
Rauchkofel Formation.
Juvenile Pa element.
a) Slightly oblique lateral view.
b) Upper view.

Fig. 13: *Ozarkodina* aff. *O. pandora* beta morph MURPHY, MATTI & WALLISER, 1981.
GBA-2006/1/14-38, Se/01/16/04.
Rauchkofel Formation.
Pa element.
a) Lateral view.
b) Upper view.
c) Oblique posterior view.

Fig. 14: *Lanea eoeleanorae* MURPHY & VALENZUELA-RÍOS, 1999.
GBA-2006/1/07-08, Se/02/01/04.
Rauchkofel Formation.
Pa element.
a) Slightly oblique lower view.
b) Anterior view.
c) Lateral view.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11b
14b
14a
14c
13a
13c
13b
100 µm

Plate 20

Fig. 1: *Pandorinellina steinhornensis praeoptima* (MASHKOVA, 1972).
GBA-2006/1/10-45, Se/03/17/04.
Hohe Warte Formation.
Pa element.
a) Lateral view.
b) Upper view.

Fig. 2: *Pandorinellina optima optima* (MOSKALENKO, 1966).
GBA-2006/1/12-07, Se/02/01/04.
Rauchkofel Formation.
Pa element.
a) Lateral view.
b) Upper view.

Fig. 3: *Pandorinellina* cf. *Pand. ebzeryi* FARRELL, 2003.
GBA-2006/1/10-12, Se/02/05/04.
Rauchkofel Formation.
Pa element.
a) Lateral view.
b) Upper view.

Fig. 4: *Pandorinellina* sp.
GBA-2006/1/07-10, Se/02/02/04.
Rauchkofel Formation.
Pa element.
a) Lateral view.
b) Lower view.
c) Anterior view.

Fig. 5: *Pandorinellina* sp.
GBA-2006/1/09-19, Se/04/-11/04.
Hohe Warte Formation.
Pa element.
a) Lateral view.
b) Lower view.

Fig. 6: *Pandorinellina* cf. *Pand. ebzeryi* FARRELL, 2003.
GBA-2006/1/08-05, Se/02/04/04.
Rauchkofel Formation.
Pa element.
a) Lateral view.
b) Lower view.

Fig. 7: *Pandorinellina miae* (BULTYNCK, 1971).
GBA-2006/1/09-06, Se/03/27/04.
Hohe Warte Formation.
Pa element.
a) Lateral view.
b) Upper view.

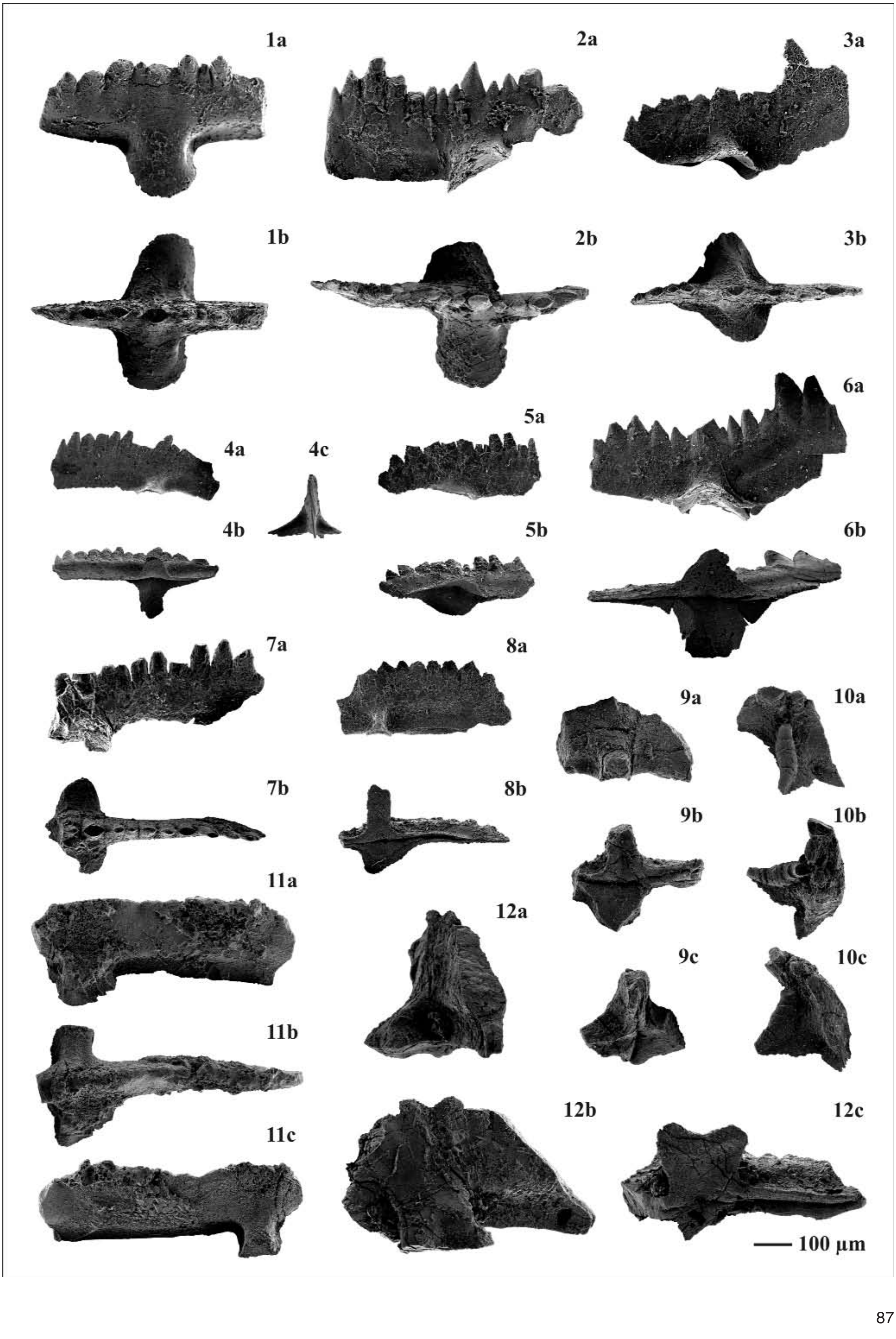
Fig. 8: *Pandorinellina* sp.
GBA-2006/1/09-20, Se/04/-11/04.
Hohe Warte Formation.
Pa element.
a) Lateral view.
b) Lower view.

Fig. 9: Unassigned specimen.
GBA-2006/1/12-37, Se/02/33/04.
Rauchkofel Formation.
Pa element.
a) Lateral view.
b) Lower view.
c) Posterior view.

Fig. 10: *Ozarkodina* aff. *O. remscheidensis eosteinhornensis* (WALLISER, 1964) alpha morph MURPHY, VALENZUELA-RÍOS & CARLS, 2004.
GBA-2006/1/03-11, Se/01/01/04.
Megaerella Formation.
Pa element.
a) Lateral view.
b) Upper view.
c) Anterior ? view.

Fig. 11: *Ozarkodina* cf. *O. pandora* zeta morph MURPHY, MATTI & WALLISER, 1981.
GBA-2006/1/12-35, Se/02/20/04.
Rauchkofel Formation.
Pa element.
a) Lateral view.
b) Upper view.
c) Lateral view.

Fig. 12: Unassigned specimen.
GBA-2006/1/12-36, Se/02/29/04.
Rauchkofel Formation.
Pa element.
a) Posterior view.
b) Lateral view.
c) Lower view.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11b
11c
12b
12c
100 µm

Plate 21

Fig. 1: *Ancyrodelloides kutscheri* BISCHOFF & SANNEMANN, 1958.
GBA-2006/1/06-15, Se/01/17/04.
Rauchkofel Formation.
Pa element.
a) Posterior view.
b) Lower view.

Fig. 2: *Ancyrodelloides kutscheri* BISCHOFF & SANNEMANN, 1958.
GBA-2006/1/06-16, Se/01/17/04.
Rauchkofel Formation.
Pa element.
a) Upper view.
b) Oblique anterior view.

Fig. 3: *Ancyrodelloides transitans* (BISCHOFF & SANNEMANN, 1958) alpha morph LANE & ORMISTON, 1979.
GBA-2006/1/10-09, Se/02/05/04.
Rauchkofel Formation.
Pa element.
a) Upper view.
b) Lateral view.

Fig. 4: *Ancyrodelloides limbacarinatus* MURPHY & MATTI, 1983.
GBA-2006/1/08-03, Se/02/04/04.
Rauchkofel Formation.
Pa element.
a) Upper view.
b) Lateral view.

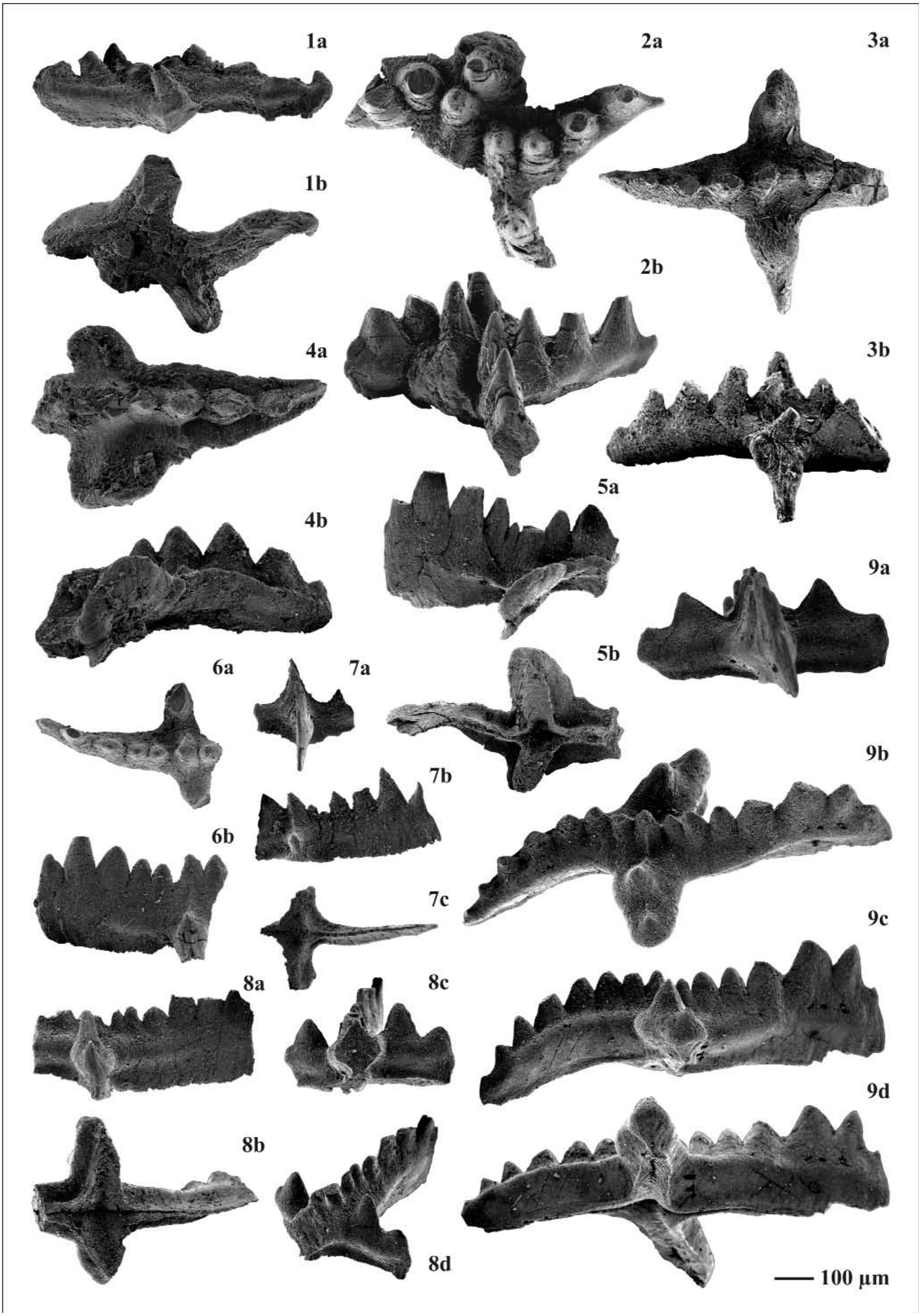
Fig. 5: *Ancyrodelloides limbacarinatus* MURPHY & MATTI, 1983.
GBA-2006/1/08-01, Se/02/04/04.
Rauchkofel Formation.
Pa element.
a) Lateral view.
b) Lower view.

Fig. 6: *Ancyrodelloides transitans* (BISCHOFF & SANNEMANN, 1958) alpha morph LANE & ORMISTON, 1979.
GBA-2006/1/07-15, Se/02/02/04.
Rauchkofel Formation.
Pa element.
a) Upper view.
b) Lateral view.

Fig. 7: *Ancyrodelloides transitans* (BISCHOFF & SANNEMANN, 1958) alpha morph LANE & ORMISTON, 1979.
GBA-2006/1/11-30, Se/01/15/04.
Rauchkofel Formation.
Pa element.
a) Anterior view.
b) Lateral view.
c) Lower view.

Fig. 8: *Ancyrodelloides transitans* (BISCHOFF & SANNEMANN, 1958) beta morph LANE & ORMISTON, 1979.
GBA-2006/1/08-06, Se/02/04/04.
Rauchkofel Formation.
Pa element.
a) Lateral view.
b) Lower view.
c) Posterior view.
d) Oblique upper view.

Fig. 9: *Ancyrodelloides transitans* (BISCHOFF & SANNEMANN, 1958) intermediate form MASTANDREA, 1985a.
GBA-2006/1/08-02, Se/02/04/04.
Rauchkofel Formation.
Pa element.
a) Anterior view.
b) Oblique upper view.
c) Lateral view.
d) Oblique lower view.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8c
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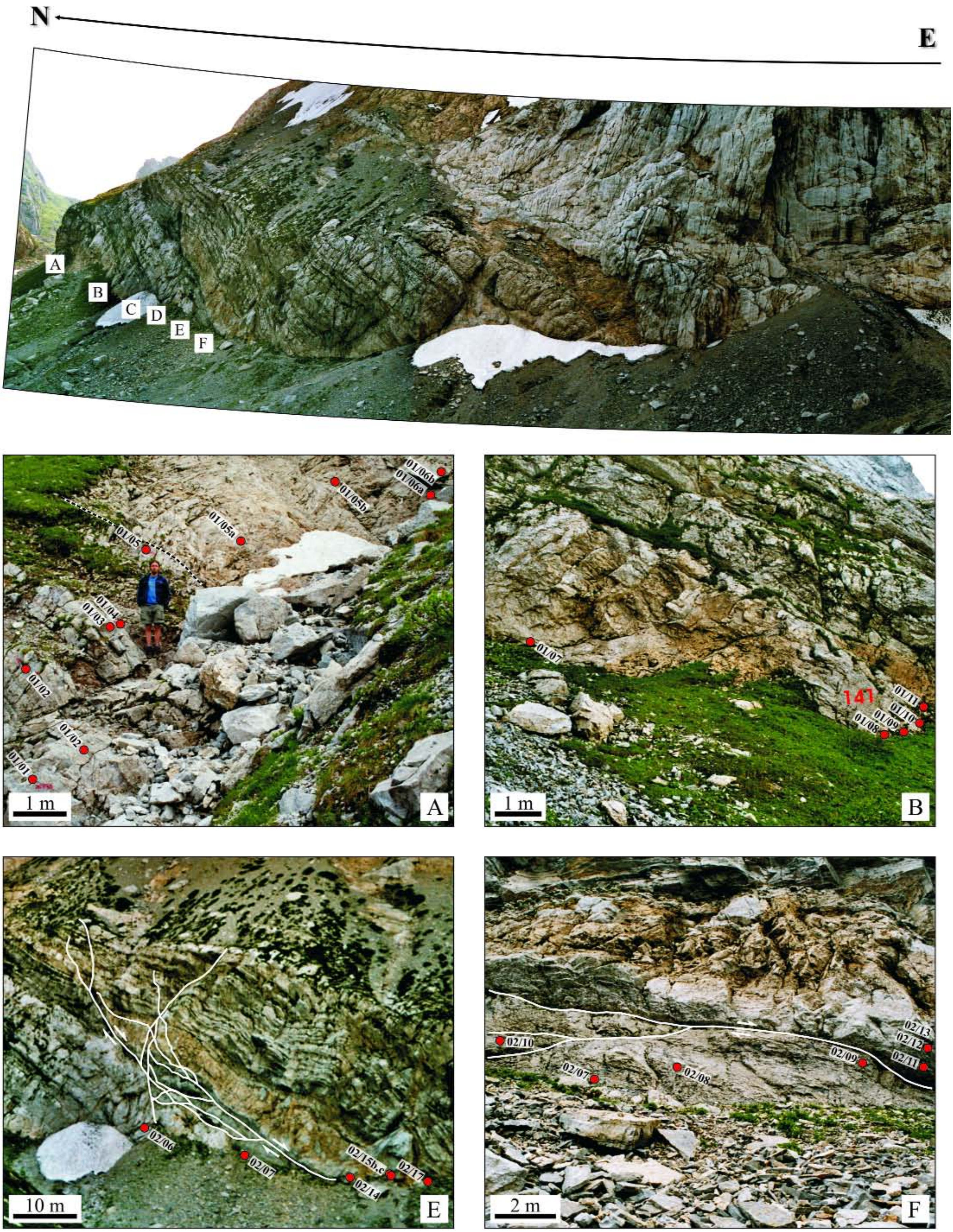
8d
100 µm

Appendix 1.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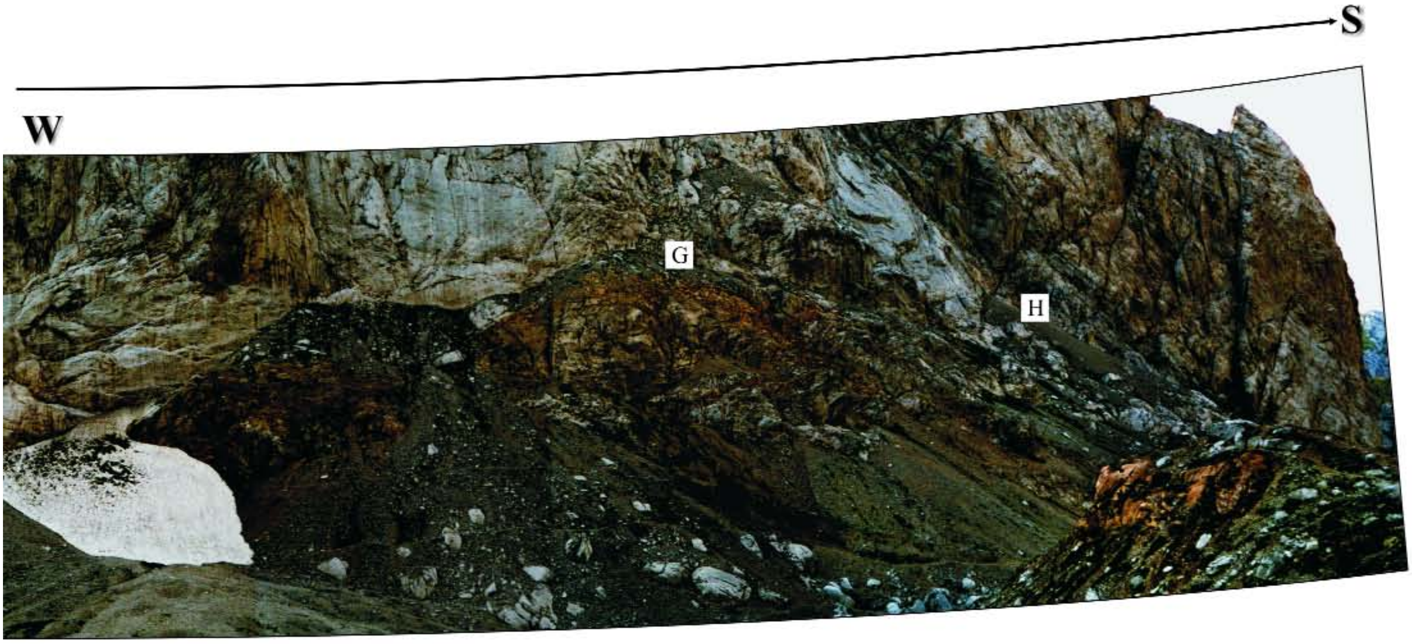
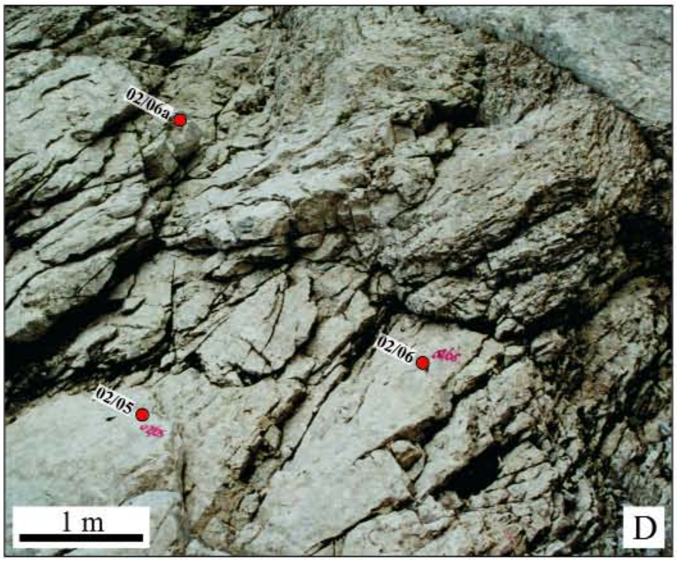
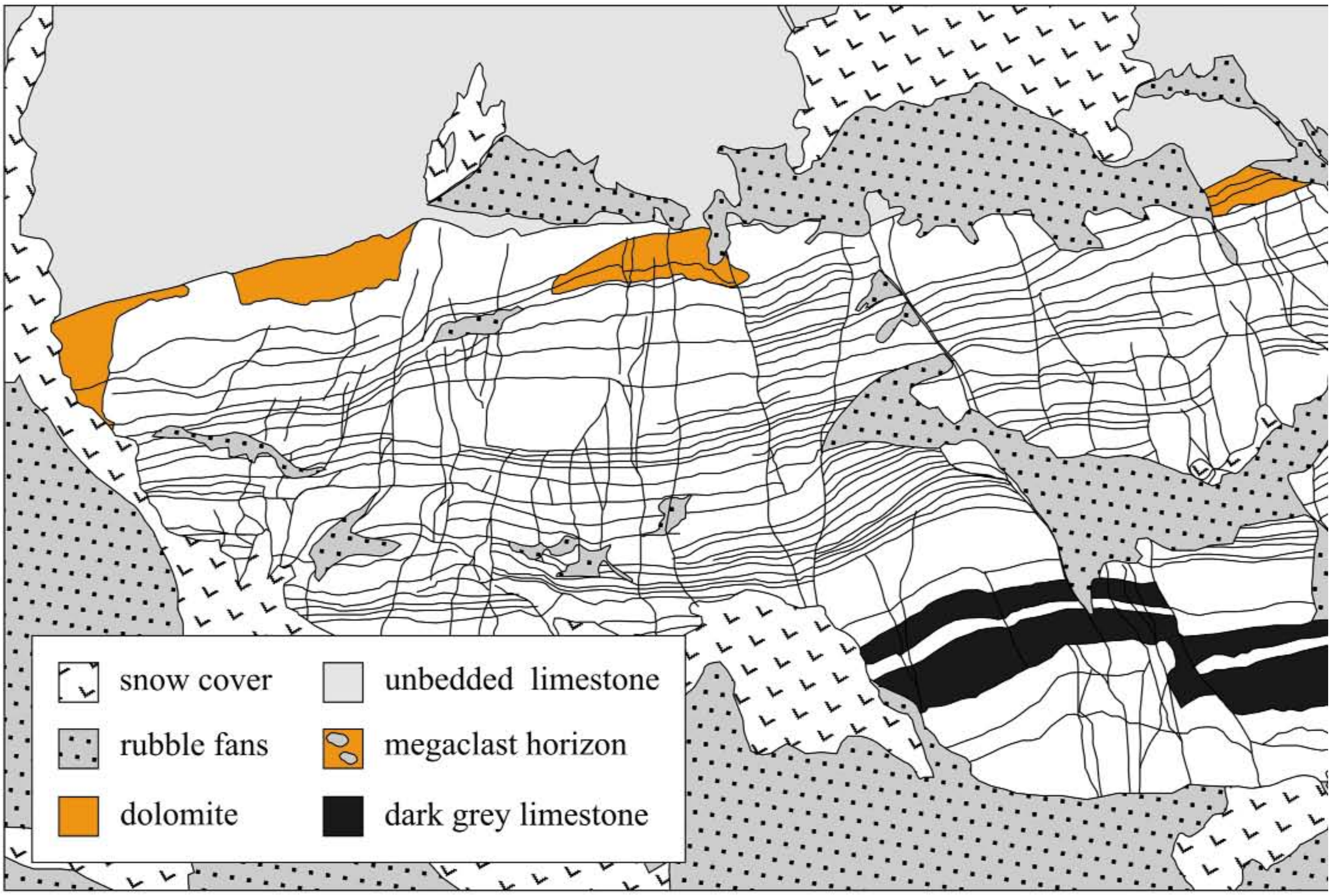
2 m
F

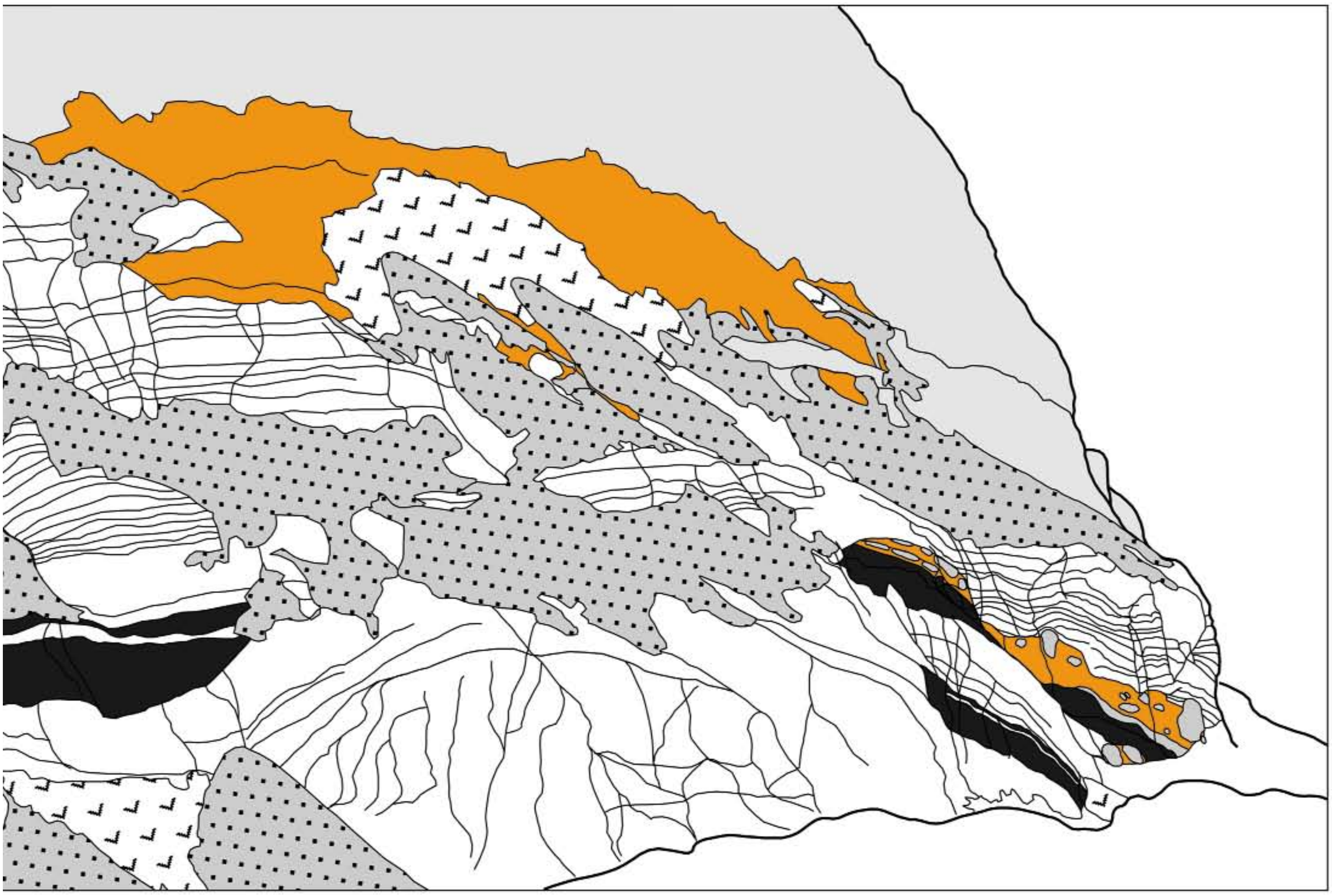
North-western wall of Mount Seewarte indicating Figs. A-H.



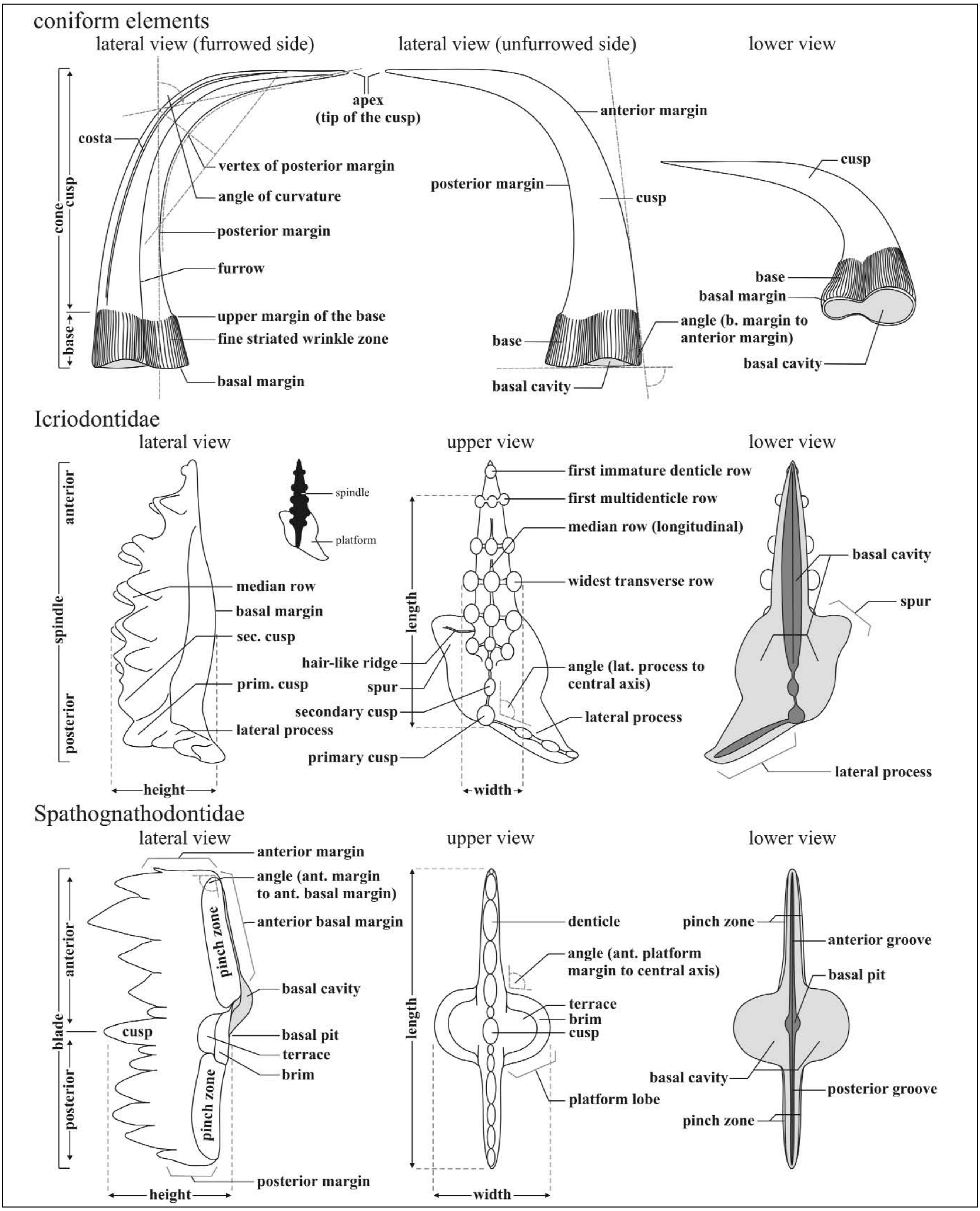


Appendix 2.


snow cover
unbedded limestone
rubble fans
megaclast horizon
dolomite
dark grey limestone

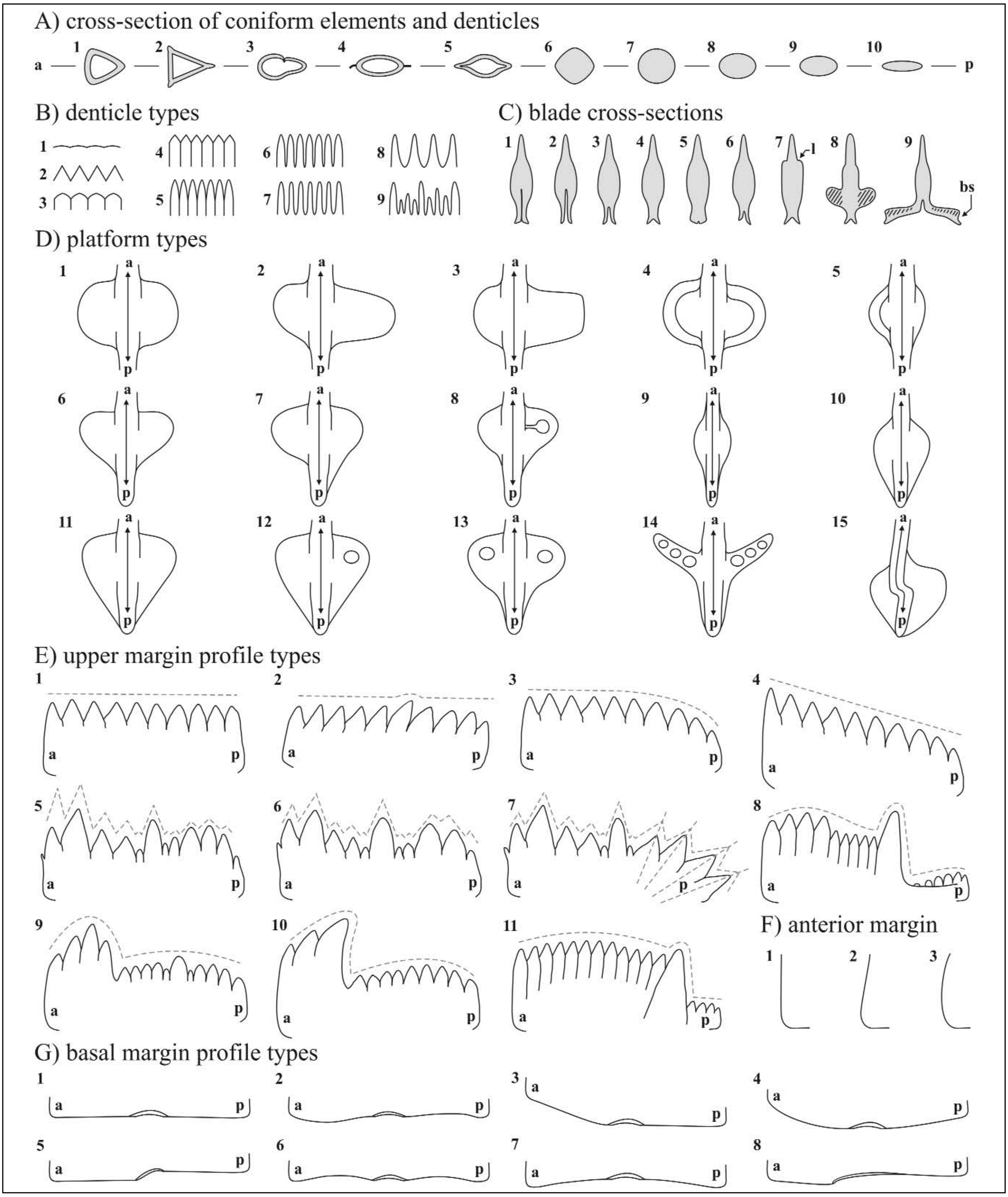


Appendix 3. Features of simple cones, Icriodontidae and Spathognathodontidae



Appendix 4. Compilation of descriptive terms visualized as simplified images ☛ ☛

A.1. triangular with gently rounded margins; A.2. triangular with keels bordering anterior and posterior margins (e.g.: *Coelocerodontus*); A.3. rounded with depression on posterior lateral faces, one side furrowed (e.g.: *Panderodus*); A.4. lenticular with anterior and posterior margin denticulate (e.g.: *Belodella anomalis*); A.5. lenticular with either margin keeled (e.g.: *Decoriconus fragilis*); A.6. sub-square; A.7. circular; A.8. oval; A.9. elliptical; A.10. lenticular. B.1. fused; B.2. triangular; B.3. stout; B.4. palisade-like; B.5. needle-like; B.6. discrete, closely-spaced; B.7. discrete, equally-spaced; B.8. discrete, wide-spaced; B.9. discrete, irregularly-denticulate. C.1. adpressed basal groove; C.2. deep basal groove; C.3. medium to moderately deep basal groove; C.4. shallow basal groove; C.5. inverted basal groove; C.6. asymmetrical basal groove; C.7. ledge along upper margin of the blade (e.g.: *Ozarkodina excavata tuma*); C.8. bench along either side of the blade (e.g.: *Ancyrodelloides trigonicus*); C.9. terrace on platform lobes with conspicuous brim sulcus (e.g.: *Lanea telleri*). D.1. symmetrical platform, lobes rounded; D.2. asymmetrical platform, right lobe tongue-like (e.g.: *Ozarkodina canadensis*); D.3. asymmetrical platform, right lobe sub-rectangular; D.4. slightly asymmetrical platform, lobes terraced (e.g.: *Lanea omoalpha*); D.5. small asymmetrical platform, left lobe



with bulge-like shoulder (e.g.: *Ozarkodina wurmi*); D.6. platform lobes heart-shaped (e.g.: *Ozarkodina r. remscheidensis*); D.7. asymmetrical platform, left lobe rounded and wide, right lobe flaring from posterior margin (e.g.: *Pandorinellina st. steinhornensis*); D.8. rounded to heart-shaped platform, right lobe ornamented with tubercle aligned to blade (e.g.: *Ozarkodina r. eosteinhornensis*); D.9. narrow symmetrical platform, lobes rounded tapering towards either margin (e.g.: *Ozarkodina r. repetitor*); D.10. spear-shaped (e.g.: *Flajsella schulzei*); D.11. nearly symmetrical platform, lobes expanded, tapering towards posterior margin, lobes unornamented (e.g.: *Ozarkodina pandora* alpha morph); D.12. symmetrical platform, one lobe ornamented, covering a single node, ridge or tubercle (e.g.: *Ozarkodina pandora* beta morph, with the exception, that this species usually has asymmetrical lobes); D.13. both platform lobes ornamented (e.g.: *Ozarkodina pandora* gamma morph); D.14. lateral platform processes denticulate, bench-like posterior blade (e.g.: *Ancyrodelloides trigonicus*); D.15. asymmetrical platform, left lobe small and rounded, right lobe expanded, sigmoidal blade axis (e.g.: *Flajsella stygia*). E.1. straight (e.g.: *Ozarkodina r. eosteinhornensis*); E.2. nearly straight with denticles pointing posteriorly (e.g.: *Ozarkodina r. repetitor*); E.3. anterior upper margin straight, posterior upper profile decreasing in denticle height (e.g.: *Pandorinellina st. steinhornensis*); E.4. descending; E.5. irregular upper profile (e.g.: *Ozarkodina r. remscheidensis*); E.6. irregular upper profile, mid-part of posterior blade bearing enlarged denticles (e.g.: *Ozarkodina camelfordensis*); E.7. fanning of posterior four denticles distinctively backward sloping (e.g.: *Ozarkodina flabellicauda*); E.8. posterior denticles paucidentate (e.g.: *Ozarkodina paucidentata*); E.9. anterior denticle-set arcuate (*Pandorinellina*: Optima group); E.10. anterior denticle-set increasing in height posteriorly (*Pandorinellina*: Exiqua group); E.11. anterior blade high with upper profile bowed, posterior blade extremely low, upper margin straight (e.g.: *Flajsella schulzei*). F.1. straight; F.2. acute angled; F.3. convex curved. G.1. straight; G.2. anterior convex, posterior concave; G.3. anterior steeply inclined, posterior straight; G.4. anterior strongly bowed, posterior gently inclined; G.5. stepped; G.6. biconcave; G.7. either lower margin curving down distally; G.8. raised, posterior slightly concave.
Abbreviations: a = anterior; bs = brim sulcus; l = ledge; p = posterior.

Appendix 5. Distribution chart of all conodont samples and specimen numbers

sample number / conodont taxa	*Belodella anomalis*	*Belodella resima*	*Belodella striata*	*Coelocerodontus* cf. *C. reduncus*	*Dvorakia* aff. *D. chattertoni*	*Dvorakia klapperi*	*Dvorakia* sp. A	*Dvorakia* sp.	*Walliserodus multistriatus*	*Pseudooneotodus beckmanni*	*Decoriconus fragilis*	*Neopanderodus aequabilis*	*Neopanderodus leptostriatus*	*Neopanderodus* sp.	*Panderodus recurvatus*	*Panderodus unicostatus*	*Panderodus* sp.	*Pedavis* sp.			*Caudicriodus* aff. *C. celtibericus*	? *Caudicriodus* sp.	*Icriodus* sp.		*Latericriodus* cf. *L. steinachensis* beta morph	*Latericriodus steinachensis* eta morph	*Latericriodus* cf. *L. steinachensis* eta morph		*Latericriodus* aff. *L. steinachensis* eta morph	*Latericriodus* sp.	*Pelekysgnathus* sp.	*Oulodus aclys*	*Oulodus elegans detorta*	*Oulodus elegans elegans*	*Oulodus greilingi hirpex*	*Oulodus spicula*	*Oulodus walliseri*	*Oulodus* sp. A	*Oulodus* sp.
																		M2b	M2c	M2d	I	I	S	M2	I	I	M2	I	I	I									
Se/02/20/04										1																													
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Se/02/18/04		20		1				2		12	1	6		1		4	3																						
Se/02/17/04		16						2										2																					
Se/02/16/04														1																									
Se/02/15c/05		20						1		53		4	3				4									2				1							2		
Se/02/15b/05		53						4		92	3	11	7	5			5								1	1		2		2									2?
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Se/02/12/04		71	3					14		25	154		5	3		6	26			8																			
Se/02/11/04		75						1		5	54						4		1?	19																			
Se/02/10/04		85						6			28		2			2	5			3																			
Se/02/09/04		9						3?		1	1		1?				4																						
Se/02/08/04		580					1	14		3	169					2	20			5																			1?
Se/02/07/04		508	1					10		10	287		2			3	20										1												
Se/02/06a/05		7						3		8	1		1?			8	3																				3		2
Se/02/06/04		21						1?		1?	2					11	3															6					2		9
Se/02/05/04		20								2	1?					6	10															6							
Se/02/04/04		257					1	14		6	89					120	26															10			5	2	5		9
Se/02/03/04		57						3?			83					36	7															7							6
Se/02/02/04		120						4		3	5					84	22															3				3	2		13
Se/02/01/04		115						3		1	22					30	17															1				4			9
Se/01/17/04		52						3		1	1					16	29			1												1			1		1?		3
Se/01/16a/05		5									2						1																						1?
Se/01/16/04		167						35		5	53					115	55																		1	4			6
Se/01/15/04		232						11		8	27					108	89															6			5	2	3		14
Se/01/14/04		3									2					6	10															2				2			5
Se/01/13/04		19								1						6	8															5?							1
Se/01/12/04		174						1?								35	10															2				1			3
Se/01/11/04		43						1?								3	6																						1
Se/01/10/04		26														4	3															1?							
Se/01/09/04		250			1			6			38				1?	62	59															1			1	1	1?		5
Se/01/08/04		161						5	2	1	46					37	13															1?							8
Se/01/07/04		58						2?			1					53	10															1							3
Se/01/06/04		160						3?			1					38	11																		1	1	2?		1
Se/01/06b/05		29									1					20	4															3							1
Se/01/06a/04		216						4		1	5					84	30																2		1	2		1	9
Se/01/05b/05		2														3	2																						1
Se/01/05a/05																4	3						2	7															1
Se/01/05/04	106	8						8	6		1					441	201																	5					5
Se/01/04/04	27	4			3			7								28	4																						1
Se/01/03/04	26				3			5		1	1?					26	1							1										5					
Se/01/02/04	2	10			1			1		1						14	7																7	17					10
Se/01/01/04	1	3			2			8								47	100																						3

Appendix 5. Continued

sample number / conodont taxa	*Ancyrodelloides kutscheri*	*Ancyrodelloides limbacarinatus*	*Ancyrodelloides transitans* alpha morph	*Ancyrodelloides transitans* beta morph	*Ancyrodelloides transitans* intermediate form	*Flajsella schulzei*	*Flajsella stygia*	*Flajsella* sp.		*Lanea omoalpha*	*Lanea eoeleanorae*	*Lanea telleri*	*Ozarkodina camelfordensis*	*Ozarkodina excavata excavata*		*Ozarkodina* aff. *O. excavata tuma*		*Ozarkodina excavata* ssp.	*Ozarkodina pandora* alpha morph	*Ozarkodina* aff. *O. pandora* beta morph	*Ozarkodina* cf. *O. pandora* zeta morph	*Ozarkodina* aff. *O. paucidentata*	*Ozarkodina* aff. *O. r. eosteinhornensis* alpha morph	*Ozarkodina* aff. *O. r. eosteinhornensis* beta morph	*Ozarkodina remscheidensis remscheidensis*		*Ozarkodina remscheidensis repetitor*	*Ozarkodina* cf. *O. remscheidensis* ssp.		*Ozarkodina wurmi*	*Pandorinellina* cf. *Pand. ebzeryi*	*Pandorinellina miae*	*Pandorinellina optima optima*	*Pandorinellina steinhornensis praeoptima*	*Pandorinellina* sp.		'Apparatus A'	unassigned specimens (mainly Ozarkodinida)	unassigned coniform elements	**sum of elements per sample**
	Pa	Pa	Pa	Pa	Pa	Pa	Pa	Pa	Pb	Pa	Pa	Pa	Pa	Pa	Pb	Pa	Pb		Pa	Pa	Pa	Pa	Pa	Pa	Pa	Pb	Pa	Pa	Pb	Pa	Pa	Pa	Pa	Pa	Sa	Pa				
Se/02/20/04														1							1																	5		8
Se/02/19/04																																						15	3	37
Se/02/18/04																																						7	6	63
Se/02/17/04																																						3	2	25
Se/02/16/04																																						1		2
Se/02/15c/05														9	3																							40	5	147
Se/02/15b/05														11	8																							62	43	312
Se/02/15/04														2	2			1																				156	3	181
Se/02/14/04														1?																								2	1	5
Se/02/13/04														6					1?																			42	31	236
Se/02/12/04														8	3										1													133	63	523
Se/02/11/04														3	2																							41	24	229
Se/02/10/04														11	1										2	1?												61	10	217
Se/02/09/04														5	1				1						2													27	3	58
Se/02/08/04														9	3																							74	39	920
Se/02/07/04														12	10										3	3												63	22	955
Se/02/06a/05			1				2							8					1						4	2												74	4	132
Se/02/06/04												1?		15	3				1						6	3												94	7	186
Se/02/05/04			1											8	3										3	2					1							157	9	229
Se/02/04/04		2		2	1		2				3	3		16	7				1?						18	2		1			1					1		336	30	970
Se/02/03/04								1						25	4					1					3	3												265	20	521
Se/02/02/04			1+1?											24	7													1								1		110	23	427
Se/02/01/04							4	1			1	1		22	4										1	2							1					160	14	413
Se/01/17/04	3		1											8	2				1						3	1		2										127	27	284
Se/01/16a/05														2	1										2													53	2	69
Se/01/16/04						8	13	3	5		1	1		19	10			1	1	1		1			9	1							1?				20	263	31	830
Se/01/15/04			1	1			11	1	3	1		1		8	9	3									18	2											6	275	27	872
Se/01/14/04	1?											1?		8	2	9	1								6	2												141	1	202
Se/01/13/04			1?		1		2	1						3		1									2													103	3	157
Se/01/12/04						1?	3	4						4	3	1									5	1												115	29	392
Se/01/11/04									1					1	1										2	1												91	11	162
Se/01/10/04														1	1?										1													52	4	93
Se/01/09/04														13	5										5	2												167	11	629
Se/01/08/04										2				8	7									1	10	5												162	19	488
Se/01/07/04										1				13	2	2?									7	3			1									112	16	285
Se/01/06/04													1	18	6			4							14	6				2								193	9	471
Se/01/06b/05														11	3										8	3			1						1	1?		110	10	206
Se/01/06a/04														35	14										18	9			1	2								335	18	787
Se/01/05b/05														6	4										3	5									1			42	2	71
Se/01/05a/05														1	1									1	10	1												36	1	68
Se/01/05/04														34	3										1?													231	62	1112
Se/01/04/04														520	87																							2506	6	3193
Se/01/03/04														362	50									1?														2421	3	2906
Se/01/02/04														13	3										1?													268	18	373
Se/01/01/04														252	40								1		1													504	10	972

Appendix 5.

Continued

sample number / conodont taxa	*Belodella anomalis*	*Belodella resima*	*Belodella striata*	*Coelocerodontus* cf. *C. reduncus*	*Dvorakia* aff. *D. chattertoni*	*Dvorakia klapperi*	*Dvorakia* sp. A	*Dvorakia* sp.	*Walliserodus multistriatus*	*Pseudooneotodus beckmanni*	*Decoriconus fragilis*	*Neopanderodus aequabilis*	*Neopanderodus leptostriatus*	*Neopanderodus* sp.	*Panderodus recurvatus*	*Panderodus unicostatus*	*Panderodus* sp.	*Pedavis* sp.			*Caudicriodus* aff. *C. celtibericus*	? *Caudicriodus* sp.	*Icriodus* sp.		*Latericriodus* cf. *L. steinachensis* beta morph	*Latericriodus steinachensis* eta morph	*Latericriodus* cf. *L. steinachensis* eta morph		*Latericriodus* aff. *L. steinachensis* eta morph	*Latericriodus* sp.	*Pelekysgnathus* sp.	*Oulodus aclys*	*Oulodus elegans detorta*	*Oulodus elegans elegans*	*Oulodus greilingi hirpex*	*Oulodus spicula*	*Oulodus walliseri*	*Oulodus* sp. A	*Oulodus* sp.
																		M2b	M2c	M2d	I	I	S	M2	I	I	M2	I	I	I									
Se/03/23/04		1														1																							
Se/03/22/04																										1													
Se/03/21/04		8						3								8																							
Se/03/20/04		34	2				2	4				1				54	7														2								
Se/03/19/04		30						5		1	1	1				25																							
Se/03/18/04		57						4			7	1	1?			10															4								
Se/03/17/04		7								3	3	1				5																							
Se/03/16/04		2														2																							
Se/03/15/04		12								2	6		1?			2	3														1?								
Se/03/14/04		4																				1																	
Se/03/13/04		3																								1													
Se/03/12/04		6				1?		1?		2						4						1																	
Se/03/11/04																																							
Se/03/10/04											1						1																						
Se/03/08/04																	1																						
Se/03/07/04		10						3?		11	10	1				3	1													1									
Se/03/06/04		3															3													1									
Se/03/05/04										1						1	1											2											
Se/03/04/04																1																							
Se/03/03/04																	1																						
Se/03/02a/04		1																																					
Se/03/02/04		3						1?						1?														1											
Se/03/01/04		5								2						1	1					1?																	
Se/02/41/04										3																				1									
Se/02/40/04										1							1									1				2?									
Se/02/39/04		2								1							1																						
Se/02/38/04																														1?									
Se/02/37/04										3																				1?									
Se/02/36/04										1							1																						
Se/02/35/04		1?								1																				2?									
Se/02/34/04		1								1							1																						
Se/02/33/04		7						3?									2													1									
Se/02/32/04		1								1																													
Se/02/31/04		3						1		4				1												1													
Se/02/30a/05		6								5				1?			1												1	1									
Se/02/30/04		6								1?							1													1?									
Se/02/29/04																																							
Se/02/28/04		9						3		46		1				3	4														1?								
Se/02/27/04		3								1							2																						
Se/02/26/04																																							
Se/02/25/04																1																							
Se/02/24/04										2							1																						
Se/02/23/04												1					1																						
Se/02/22/04		1								1							1																						
Se/02/21/04		1												1																									

Appendix 5. Continued

sample number / conodont taxa	*Ancyrodelloides kutscheri*	*Ancyrodelloides limbacarinatus*	*Ancyrodelloides transitans* alpha morph	*Ancyrodelloides transitans* beta morph	*Ancyrodelloides transitans* intermediate form	*Flajsella schulzei*	*Flajsella stygia*	*Flajsella* sp.		*Lanea omoalpha*	*Lanea eoeleanorae*	*Lanea telleri*	*Ozarkodina camelfordensis*	*Ozarkodina excavata excavata*		*Ozarkodina* aff. *O. excavata tuma*		*Ozarkodina excavata* ssp.	*Ozarkodina pandora* alpha morph	*Ozarkodina* aff. *O. pandora* beta morph	*Ozarkodina* cf. *O. pandora* zeta morph	*Ozarkodina* aff. *O. paucidentata*	*Ozarkodina* aff. *O. r. eosteinhornensis* alpha morph	*Ozarkodina* aff. *O. r. eosteinhornensis* beta morph	*Ozarkodina remscheidensis remscheidensis*		*Ozarkodina remscheidensis repetitor*	*Ozarkodina* cf. *O. remscheidensis* ssp.		*Ozarkodina wurmi*	*Pandorinellina* cf. *Pand. ebzeryi*	*Pandorinellina miae*	*Pandorinellina optima optima*	*Pandorinellina steinhornensis praeoptima*	*Pandorinellina* sp.		'Apparatus A'	unassigned specimens (mainly Ozarkodinida)	unassigned coniform elements	**sum of elements per sample**
	Pa	Pa	Pa	Pa	Pa	Pa	Pa	Pa	Pb	Pa	Pa	Pa	Pa	Pa	Pb	Pa	Pb		Pa	Pa	Pa	Pa	Pa	Pa	Pa	Pb	Pa	Pa	Pb	Pa	Pa	Pa	Pa	Pa	Sa	Pa				
Se/03/23/04																																								**2**
Se/03/22/04																																						1		**2**
Se/03/21/04																																						1	2	**22**
Se/03/20/04																																						1	12	**119**
Se/03/19/04																																						10	3	**76**
Se/03/18/04																																						7	5	**96**
Se/03/17/04																																		2				3	1	**25**
Se/03/16/04																																							2	**6**
Se/03/15/04														1	1																							5	10	**44**
Se/03/14/04																																						1	3	**9**
Se/03/13/04																																						4	2	**10**
Se/03/12/04																																						6	3	**24**
Se/03/11/04																																							1	**1**
Se/03/10/04																																								**2**
Se/03/08/04																																							2	**3**
Se/03/07/04																																							4	**44**
Se/03/06/04																																						3	6	**16**
Se/03/05/04																																						5	2	**12**
Se/03/04/04																																						4	1	**6**
Se/03/03/04																																						2	4	**7**
Se/03/02a/04																																						1		**2**
Se/03/02/04																																						5		**11**
Se/03/01/04																																						8	3	**21**
Se/02/41/04																																						1		**5**
Se/02/40/04																																							2	**7**
Se/02/39/04																																							3	**7**
Se/02/38/04																																							14	**15**
Se/02/37/04																																						2	1	**7**
Se/02/36/04																																						1	1	**4**
Se/02/35/04																																						1		**5**
Se/02/34/04																																						4		**7**
Se/02/33/04																																						4		**17**
Se/02/32/04																																						3		**5**
Se/02/31/04																																						1	1	**12**
Se/02/30a/05															1																							3	1	**20**
Se/02/30/04																																						1	1	**11**
Se/02/29/04																																						2		**2**
Se/02/28/04														2	1			3																				7	6	**86**
Se/02/27/04																																						3	2	**11**
Se/02/26/04																																						1		**1**
Se/02/25/04																																						4	1	**6**
Se/02/24/04																																						6		**9**
Se/02/23/04																																						2		**4**
Se/02/22/04																																						12	2	**17**
Se/02/21/04																																						3	1	**6**

Appendix 5.

Continued

sample number / conodont taxa	*Belodella anomalis*	*Belodella resima*	*Belodella striata*	*Coelocerodontus* cf. *C. reduncus*	*Dvorakia* aff. *D. chattertoni*	*Dvorakia klapperi*	*Dvorakia* sp. A	*Dvorakia* sp.	*Walliserodus multistriatus*	*Pseudooneotodus beckmanni*	*Decoriconus fragilis*	*Neopanderodus aequabilis*	*Neopanderodus leptostriatus*	*Neopanderodus* sp.	*Panderodus recurvatus*	*Panderodus unicostatus*	*Panderodus* sp.	*Pedavis* sp.			*Caudicriodus* aff. *C. celtibericus*	? *Caudicriodus* sp.	*Icriodus* sp.		*Latericriodus* cf. *L. steinachensis* beta morph	*Latericriodus steinachensis* eta morph	*Latericriodus* cf. *L. steinachensis* eta morph		*Latericriodus* aff. *L. steinachensis* eta morph	*Latericriodus* sp.	*Pelekysgnathus* sp.	*Oulodus aclys*	*Oulodus elegans detorta*	*Oulodus elegans elegans*	*Oulodus greilingi hirpex*	*Oulodus spicula*	*Oulodus walliseri*	*Oulodus* sp. A	*Oulodus* sp.
																		M2b	M2c	M2d	I	I	S	M2	I	I	M2	I	I	I									
sum	162	4520	8	1	10	13	6	222	8	360	1160	42	30	18	2	1727	888	2	2	46	1	5	2	8	1	10	1	7	4	19	9	56	9	27	15	22	21	1	133
Se/04/15/04		2				1?																																	
Se/04/13/04		1				2																																	
Se/04/12/04		1				1																																	
Se/04/10/04		8										1																											
Se/04/09/04																																							
Se/04/08/04		8				1										1																							
Se/04/07/04		3	1?																																				
Se/04/05/04		27														4																							
Se/04/04/04		63														3																							
Se/04/03/04		2+1?														2																							
Se/04/02/04		9														2																							
Se/04/01/04																																							
Se/04/-01/04		18				1						2																											
Se/04/-02/04		3																																					
Se/04/-03/04		5				1				2						8																							
Se/04/-04/04		20					1			2						1																							
Se/04/-05/04		1														2																							
Se/04/-06/04		27										1	1?			6	1																						
Se/04/-07/04		7														4										1													
Se/04/-08/04		9														2																							
Se/04/-09/04		29	1			1										13														1?									
Se/04/-10/04		17				1?										9																							
Se/04/-11/04		206						3								29																							
Se/04/-12/04		5					1									7																							
Se/03/46/05																1																							
Se/03/45/05																2					1																		
Se/03/44/04		5														5																							
Se/03/43/04		2														1?													1										
Se/03/42/04		7											1			4																							
Se/03/41/04		11				1?						1				5															1								
Se/03/40/04		12														4																							
Se/03/39/04		4														1																							
Se/03/38/04		2								3						1														1?									
Se/03/37/04		1														1												1											
Se/03/36/04						1																																	
Se/03/35/04		1														2																							
Se/03/33/04		1																																					
Se/03/31/04		3														5																							
Se/03/30/04		7														3																							
Se/03/29/04		7								2						2						1				1													
Se/03/28/04		3																																					
Se/03/27/04		5												1	1	1																							
Se/03/26/04		1																																					
Se/03/25/04		7														1																							
Se/03/24/04		15				1						3				6						1				1		1	2	1?									

Appendix 5.

sample number / conodont taxa	Ancyrodelloides kutscheri	Ancyrodelloides limbacarinatus	Ancyrodelloides transitans alpha morph	Ancyrodelloides transitans beta morph	Ancyrodelloides transitans intermediate form	Flajsella schulzei	Flajsella stygia	Flajsella sp.		Lanea omoalpha	Lanea eoeleanorae	Lanea telleri	Ozarkodina camelfordensis	Ozarkodina excavata excavata		Ozarkodina aff. O. excavata tuma		Ozarkodina excavata ssp.	Ozarkodina pandora alpha morph	Ozarkodina aff. O. pandora beta morph	Ozarkodina cf. O. pandora zeta morph	Ozarkodina aff. O. paucidentata	Ozarkodina aff. O. r. eosteinhornensis alpha morph	Ozarkodina aff. O. r. eosteinhornensis beta morph	Ozarkodina remscheidensis remscheidensis		Ozarkodina remscheidensis repetitor	Ozarkodina cf. O. remscheidensis ssp.		Ozarkodina wurmi	Pandorinellina cf. Pand. ebzeryi	Pandorinellina miae	Pandorinellina optima optima	Pandorinellina steinhornensis praeoptima	Pandorinellina sp.		'Apparatus A'	unassigned specimens (mainly Ozarkodinida)	unassigned conform elements	sum of elements per sample
	Pa	Pa	Pa	Pa	Pa	Pa	Pa	Pa	Pb	Pa	Pa	Pa	Pa	Pa	Pb	Pa	Pb		Pa	Pa	Pa	Pa	Pa	Pa	Pa	Pb	Pa	Pa	Pb	Pa	Pa	Pa	Pa	Pa	Sa	Pa				
sum	**4**	**2**	**7**	**3**	**2**	**9**	**37**	**11**	**9**	**4**	**5**	**8**	**1**	**1547**	**318**	**17**	**1**	**10**	**7**	**2**	**1**	**1**	**1**	**3**	**169**	**60**	**2**	**4**	**3**	**4**	**2**	**1**	**2**	**2**	**2**	**5**	**26**	**10466**	**835**	**23171**
Se/04/15/04																																							1	4
Se/04/13/04																																							1	4
Se/04/12/04																																								2
Se/04/10/04																																							8	17
Se/04/09/04																																							1	1
Se/04/08/04																																						1		11
Se/04/07/04																																							2	6
Se/04/05/04																																						1	23	55
Se/04/04/04																																							2	68
Se/04/03/04																																						1		6
Se/04/02/04																																							1	12
Se/04/01/04																																							1	1
Se/04/-01/04																																							1	22
Se/04/-02/04																																							1	4
Se/04/-03/04																																							1	17
Se/04/-04/04																																						1	1	26
Se/04/-05/04																																								3
Se/04/-06/04																																							2	38
Se/04/-07/04																																								12
Se/04/-08/04																																							1	12
Se/04/-09/04																		1?																				1		47
Se/04/-10/04																																						3		30
Se/04/-11/04																											2									2		17	1	260
Se/04/-12/04																																						2	1	16
Se/03/46/05																																								1
Se/03/45/05																																						1		4
Se/03/44/04																																							1	11
Se/03/43/04																																						2		6
Se/03/42/04																																						5		17
Se/03/41/04																																						7		26
Se/03/40/04																																						5		21
Se/03/39/04																																						1		6
Se/03/38/04																																						3		10
Se/03/37/04																																						3		6
Se/03/36/04														1																										2
Se/03/35/04																																						1	1	5
Se/03/33/04																																								1
Se/03/31/04																1																								9
Se/03/30/04														1																								5		16
Se/03/29/04																																						10		23
Se/03/28/04														1?																								2		6
Se/03/27/04														1																		1						5		15
Se/03/26/04																																						1?		2
Se/03/25/04																																						3		11
Se/03/24/04														4																								22		57

Appendix 6.

Basic data of conodont samples. MF-type = microfacies-type

sample no.	distance	sample	weight of residues (g)					% of sum:	color of		rock classification	d 13C/12C		d 18O/16O		Conodont Apatite Isotopes		
Seewarte	(cm)	weight (g)	0.63-250µm	0.63µm	125-250µm	500µm	>500µm	0.63-250µm	rock	residues	MF-type:	mean	st.dev.	mean	st.dev.	d 13C/12C	d 18O/16O	weight (mg)
Se/01/01/04	50	5000	48.5					0.97	5YR4/1	5Y8/1	3a	1.33	0.02	-9.26	0.02			
Se/01/02/04	110	3000	25.4			6.6		0.85	N3	5Y8/1	2							0.58
Se/01/03/04	260	6500	138.2	60	78.2			2.13	N5	5Y8/1	2	1.09	0.02	-4.60	0.06			0.8
Se/01/04/04	290	3500	32.2			2.1		0.92	N3	5Y8/1	2	1.43	0.04	-4.92	0.05			0.918
Se/01/05/04	460	3000	112.6	66.9	45.7	8.5		3.75	N6	N8	2; + dolomite	1.61	0.02	-8.65	0.03			
Se/01/05a/05	660	2500	135.8	31	104.8	4.1	120	5.43	N7	N9	dolomite							
Se/01/05b/05	1160	2000	33.4	15.4	18	3	120	1.67	N5	N8	dolomite							
Se/01/06a/04	1310	6000	213.8	130.8	83			3.56	N5	N8	dolomite; prim: 3a	2.02	0.02	-4.07	0.02			
Se/01/06b/05	1400	2500	62.2	37	25.2	14.8	50	2.49	5Y6/1	N8	dolomite; prim: 3a							
Se/01/06/04	1510	6000	297.9	142.5	155.4			4.97	N5	N8	dolomite; prim: 2	1.49	0.02	-5.93	0.05			0.66
Se/01/07/04	1660	3000	32.5	19.9	12.6			1.08	N6	N7	dolomite	1.67	0.01	-4.44	0.04			
Se/01/08/04	1760	3000	5.8					0.19	N3	N6	3a; + dolomite	0.71	0.01	-8.89	0.01			0.6
Se/01/09/04	1910	5000	42.3					0.85	N3	N6	3a	0.73	0.01	-9.05	0.03			
Se/01/10/04	2060	3000	57.1	41.1	16			1.9	N5	5Y8/1	dolomite; prim: 2	1.49	0.02	-4.51	0.03			
Se/01/11/04	2210	2500	89.1	40.1	49			3.56	N7	5Y8/1	dolomite	1.53	0.02	-3.48	0.03			0.59
Se/01/12/04	2360	3000	30.2	18.7	11.5			1.01	N5	N8	3a; + dolomite							
Se/01/13/04	2560	5000	29.5			3.7		0.59	N5	N5	6; + dolomite	1.03	0.01	-9.07	0.03			0.72
Se/01/14/04	2710	4000	49.7	26.7	23			1.24	N3	N5	3a	0.99	0.02	-7.59	0.02			
Se/01/15/04	2910	6000	45.3					0.76	N1	N6	3a	0.86	0.02	-7.19	0.02			
Se/01/16/04	3110	3000	20.5					0.68	N3	N6	3a	0.92	0.02	-5.04	0.01			0.66
Se/01/16a/05	3220	2000	79.9	44.8	35.1	4.8	45	4	N4	N8	3a							
Se/01/17/04	3310	4000	13.2					0.33	N4	N6	3a	1.10	0.02	-4.19	0.02			
Se/02/01/04	3460	4000	64.4	42.4	22	6.1		1.61	N3	N5	2; 3a	0.89	0.05	-5.79	0.12			
Se/02/02/04	3710	4000	12.8					0.32	N4	N6	3a; + dolomite	1.07	0.02	-5.64	0.03			
Se/02/03/04	3860	4000	4					0.1	N3	N6	2; 3a	1.45	0.02	-5.01	0.01			
Se/02/04/04	4000	3000	4.6					0.15	N4	N6	3a	1.61	0.03	-5.14	0.03			0.54
Se/02/05/04	4150	3000	123.6	86.2	37.4			4.12	N5	N8	6	1.69	0.02	-6.87	0.02			0.59
Se/02/06/04	4300	5000	66.6	39.6	27			1.33	N4	N8	2; 3a	1.56	0.01	-6.03	0.05			
Se/02/06a/05	4600	2000	17.8	10.4	7.4	1		0.89	N4	N8	6							
Se/02/07/04	5100	4000	22.7	8.4	14.3			0.57	N3	N3	8?	1.79	0.11	-4.48	0.15			
Se/02/08/04	5250	5000	5					0.1	N3	N3	8?	1.85	0.02	-6.63	0.02			
Se/02/09/04	5450	3000	6.1	3.3	2.8			0.2	N3	N2	8?							
Se/02/10/04	5500	3000	6.5					0.22	N3	N3	8?	1.42	0.01	-7.51	0.01			
Se/02/11/04	5590	2000	2.8					0.14	N3	N3	3a	1.63	0.02	-7.84	0.04			
Se/02/12/04	5610	5000	14.5					0.29	N3	N4	2; 3a	1.91	0.02	-6.92	0.02			
Se/02/13/04	5740	3500	1.8					0.05	N3	N4	3a	1.75	0.01	-7.76	0.03			

Appendix 6. Continued

sample no.	distance	sample	weight of residues (g)					% of sum:	color of		rock classification	d 13C/12C		d 18O/16O		Conodont Apatite Isotopes		
Seewarte	(cm)	weight (g)	0.63-250µm	0.63µm	125-250µm	500µm	>500µm	0.63-250µm	rock	residues	MF-type	mean	st.dev.	mean	st.dev.	d 13C/12C	d 18O/16O	weight (mg)
Se/02/14/04	5890	5000	27.3					0.55	N5	N8	2; 3a	3.11	0.02	-6.84	0.03			
Se/02/15/04	6090	3500	84.5	41.5	43			2.41	N7	N8	dolomite	2.55	0.03	-3.71	0.01			0.76
Se/02/15a/05	6280	2000	236.7	37.9	198.8	11.3		11.84	5Y4/1	N8	3a; dolomite							
Se/02/15b/05	6300	2000	27.5	14.4	13.1	21.4	60	1.38	10YR5/4	5Y8/1	3a; dolomite							
Se/02/15c/05	6310	650	5.4	3	2.4	3.5		0.83	5Y6/1	10YR6/2	3a; dolomite							
Se/02/16/04	6320	3000	60.2	24.8	35.4			2.01	N6	N8	6	2.56	0.01	-6.49	0.02			
Se/02/17/04	6520	2000	2.7					0.14	N6	N8	6	3.15	0.02	-5.87	0.01			
Se/02/18/04	6640	2000	11.2					0.56	5YR7/2	5YR8/1	dolomite	2.90	0.03	-2.11	0.03			
Se/02/19/04	6820	4000	11.9			3		0.3	N4	5YR4/1	2; 6	3.15	0.02	-2.85	0.02			
Se/02/20/04	7020	6000	170.8	28.8	142	35.3		2.85	N4	N7	6	3.29	0.01	-4.28	0.02			
Se/02/21/04	7200	3000	381	139.7	241.3			12.7	N5	N8	3a							
Se/02/22/04	7400	5000	426.8	135.1	291.7	8.5		8.54	N6	N7	3a; + dolomite							0.37
Se/02/23/04	7600	5000	299.9	112	187.9			6	N5	N8	2; + dolomite	2.78	0.04	-3.81	0.06			
Se/02/24/04	7800	3500	372.5	126.2	246.3			10.64	N7	N8	2; + dolomite	2.96	0.03	-3.30	0.05			
Se/02/25/04	8000	2000	133.4	58.1	75.3			6.67	N6	N8	dolomite; prim: 6	3.10	0.03	-1.61	0.06			
Se/02/26/04	8200	3000	85.6	36.7	48.9			2.85	N6	N8	3a; + dolomite	2.85	0.01	-3.60	0.03			
Se/02/27/04	8400	4000	28	13	15			0.7	N6	N7	2; 3a; + dolomite	3.00	0.01	-3.82	0.05			
Se/02/28/04	8660	3000	133.4	81	52.4	5.3		4.45	N5	N7	3a							
Se/02/29/04	8860	1000	17.7					1.77	N5	N7	2	2.23	0.02	-5.60	0.05			
Se/02/30/04	9080	3000	30	20.4	9.6			1	N5	N6	3a; + dolomite	2.64	0.02	-6.04	0.06			
Se/02/30a/05	9180	2000	15.2	8.5	6.7	6.1		0.76	5Y2/1	N8	6							
Se/02/31/04	9250	2000	19.4					0.97	N4	N7	6	3.08	0.02	-4.27	0.03			
Se/02/32/04	9450	4000	248.9	55.1	193.8			6.22	N4	N8	6	3.06	0.03	-3.20	0.03			
Se/02/33/04	9650	5000	46.6	22.9	23.7			0.93	N4	N7	6	2.78	0.04	-5.41	0.03			
Se/02/34/04	9850	5000	108.6			3.2		2.17	N4	N7	6	3.15	0.04	-3.06	0.05			
Se/02/35/04	10050	4000	226.4	58.8	167.6	35.7		5.66	N7	N8	2; 3a	2.62	0.05	-3.15	0.09			
Se/02/36/04	10250	3000	56.8	34.7	22.1			1.89	N5	N7	2	2.68	0.04	-3.76	0.05			
Se/02/37/04	10450	2000	25.9					1.3	N7	N8	6; + dolomite	2.47	0.03	-3.38	0.03			
Se/02/38/04	10650	3000	0					0	5Y8/1	N8	6; + dolomite	2.40	0.03	-4.38	0.04			0.45
Se/02/39/04	10850	2000	89	48.4	40.6			4.45	N6	N7	3a; + dolomite	2.77	0.02	-2.97	0.02			
Se/02/40/04	11150	5000	377.8	105.8	272	17.4		7.56	N5	N7	3a; + dolomite	2.82	0.02	-3.73	0.04			
Se/02/41/04	?11850?	2000	73.6	43.1	30.5			3.68	N6	N7	3a; + dolomite	2.63	0.03	-4.08	0.02			
Se/03/01/04	11580	3000	207.2	93.3	113.9			6.91	N6	N8	3a; + dolomite	2.41	0.03	-3.91	0.05			
Se/03/02/04	11780	2000	137.2	81.3	55.9			6.86	5Y8/1	5Y8/1	3a; + dolomite	2.50	0.02	-3.46	0.02			
Se/03/02a/04	?11980?	2000	115.9	32.8	83.1			5.8	N7	N8	6; + dolomite	2.29	0.04	-7.59	0.05			
Se/03/03/04	12180	2500	167.6	40	127.6			6.7	N6	5Y8/1	3a; + dolomite	2.35	0.02	-4.04	0.03			

Appendix 6. Continued

sample no.	distance	sample	weight of residues (g)					% of sum:	color of		rock classification	d 13C/12C		d 18O/16O		Conodont Apatite Isotopes		
Seewarte	(cm)	weight (g)	0.63-250µm	0.63µm	125-250µm	500µm	>500µm	0.63-250µm	rock	residues	MF-type	mean	st.dev.	mean	st.dev.	d 13C/12C	d 18O/16O	weight (mg)
Se/03/04/04	12430	4000	50.4					1.26	N7	5Y8/1	3a; + dolomite	2.37	0.02	-5.91	0.02			
Se/03/05/04	12680	5000	48.8					0.98	N6	5Y8/1	2; 3a; + dolomite	2.89	0.04	-4.36	0.06			
Se/03/06/04	12930	4000	22.7					0.57	N6	5Y8/1	6; + dolomite	2.49	0.01	-7.14	0.03			
Se/03/07/04	13080	6000	21.2					0.35	N6	N8	2; 3a; + dolomite	2.20	0.03	-6.14	0.04			
Se/03/08/04	13230	4000	132.8	54.7	78.1			3.32	N7	5Y8/1	6; + dolomite	2.37	0.03	-7.45	0.07			
Se/03/09/04	13380	2000	9.6					0.48	N6	5Y8/1	6	2.56	0.03	-7.18	0.05			
Se/03/10/04	13630	2000	1.6					0.08	5YR6/1	N8	6	2.44	0.04	-4.87	0.05			
Se/03/11/04	13880	2500	2.6					0.1	N7	N8	6	1.94	0.02	-3.82	0.02			
Se/03/12/04	14180	4500	6.2					0.14	N7	N8	6	2.50	0.02	-3.47	0.03			
Se/03/13/04	14330	4000	5.3					0.13	N6	N8	6	2.63	0.02	-4.32	0.04			
Se/03/14/04	14580	6000	7.8					0.13	5Y8/1	5Y8/1	6	2.49	0.02	-5.14	0.03			
Se/03/15/04	14780	6000	5.9					0.1	5Y8/1	5Y8/1	6	2.30	0.04	-7.27	0.04			
Se/03/16/04	14930	4000	7.9					0.2	N7	5Y8/1	3a	2.45	0.04	-4.32	0.04			
Se/03/17/04	15130	6500	72.6					1.12	N7	N8	6	2.46	0.04	-5.45	0.05			
Se/03/18/04	15380	3000	16.6					0.55	N7	N8	dolomite; prim: 3a	1.35	0.02	-3.83	0.07			
Se/03/19/04	15830	3000	14.2					0.47	N7	N8	6; + dolomite	2.88	0.03	-3.28	0.03			
Se/03/20/04	15980	2000	10.4					0.52	N7	N8	6	2.27	0.04	-6.26	0.05			
Se/03/21/04	16180	2000	23.4					1.17	N7	N8	5b	2.16	0.03	-6.59	0.06			
Se/03/22/04	16580	2000	10.8					0.54	N7	N8	3a	2.41	0.02	-4.80	0.06			
Se/03/23/04	16780	3000	25.7					0.86	N7	N8	5b	2.11	0.02	-5.50	0.04			
Se/03/24/04	17180	6000	97.3					1.62	N7	N8	3a	2.67	0.01	-3.68	0.04			
Se/03/25/04	17380	3000	19			9.5	20.3	0.63	N7	N8	3a	2.01	0.03	-4.85	0.04			
Se/03/26/04	17630	4000	21.5					0.54	N7	N8	3a	3.00	0.02	-2.90	0.02			
Se/03/27/04	17880	4000	2.2					0.06	N7	N8	3a	2.57	0.03	-4.12	0.05			
Se/03/28/04	18180	1500	3.6					0.24	N7	N8	3a	2.79	0.03	-2.99	0.05			
Se/03/29/04	18430	4000	12					0.3	N7	N8	3a	2.58	0.03	-4.13	0.04			
Se/03/30/04	18730	3000	11.2					0.37	N7	N8	6	2.80	0.01	-3.91	0.02			
Se/03/31/04	19030	2500	2.5					0.1	N7	N8	6	2.78	0.02	-3.67	0.02			
Se/03/32/04	19330	2500	1.5					0.06	N7	N8	2	2.68	0.01	-4.27	0.05			
Se/03/33/04	19630	1500	1.7					0.11	N7	N8	6	2.70	0.01	-4.43	0.04			
Se/03/34/04	19880	2500	1.5					0.06	N7	N8	6	2.60	0.02	-4.70	0.04			
Se/03/35/04	20080	2000	1.5					0.08	N7	N8	6	2.55	0.03	-6.12	0.03			
Se/03/36/04	20280	1000	2					0.2	N7	N8	6	2.90	0.01	-5.31	0.02			
Se/03/37/04	20580	2000	1.5					0.08	N7	N8	6	2.83	0.03	-5.45	0.03			
Se/03/38/04	20780	2500	60					2.4	N7	N8	5b	2.42	0.03	-5.98	0.05			
Se/03/39/04	21180	2500	8.1			1.5		0.32	N7	5Y8/1	5b	2.33	0.02	-7.40	0.04			

Appendix 6. Continued

sample no.	distance	sample	weight of residues (g)					% of sum:	color of		rock classification	d 13C/12C		d 18O/16O		Conodont Apatite Isotopes		
Seewarte	(cm)	weight (g)	0.63-250µm	0.63µm	125-250µm	500µm	>500µm	0.63-250µm	rock	residues	MF-type	mean	st.dev.	mean	st.dev.	d 13C/12C	d 18O/16O	weight (mg)
Se/03/40/04	21480	2500	8.8					0.35	N7	N8	6	2.67	0.02	-5.99	0.04			
Se/03/41/04	21780	3000	34.8					1.16	N7	5Y8/1	2; 3a; + dolomite	2.60	0.02	-6.20	0.06			
Se/03/42/04	22080	2000	19			1.4		0.95	N7	5YR6/1	3a	2.32	0.03	-6.37	0.06			
Se/03/43/04	22330	3000	64.2	27.9	36.3	8.6		2.14	N6	N6	6	2.36	0.02	-6.48	0.03			
Se/03/44/04	22630	4000	19.8					0.5	N6	5YR6/1	2; 3a	2.49	0.04	-6.44	0.04			
Se/03/45/05	23430	2300	96.8	41.3	55.5	20		4.2	N6	5Y8/1	2; 3a							
Se/03/46/05	24230	2500	11.6	5.1	6.5	1	40	0.46	5Y6/1	5Y8/1	2; 3a							
Se/03/47/05	25030	2000	5.7	3.1	2.6	1.5		0.29	5Y4/1	5Y8/1	5b							
Se/04/-12/04	?25650?	3000	17.8					0.6	N6	N8	5b	2.44	0.03	-4.93	0.02			
Se/04/-11/04	25950	4000	67.2					1.68	N6	N8	6	2.17	0.02	-5.10	0.05			
Se/04/-10/04	26100	3000	9.9					0.33	N7	5Y8/1	5b	2.31	0.03	-5.11	0.05			
Se/04/-09/04	26300	2500	21.1					0.84	N7	5Y8/1	6	2.66	0.03	-3.30	0.03			
Se/04/-08/04	26450	2000	16.2					0.81	N7	5Y8/1	5b	2.23	0.03	-5.09	0.03			
Se/04/-07/04	26600	2000	12.7					0.64	N7	N8	6	2.59	0.03	-2.97	0.05			
Se/04/-06/04	26800	3000	82.1					2.74	N7	N8	5b	2.50	0.03	-2.79	0.04			
Se/04/-05/04	27100	2000	2.3					0.12	N6	N8	5b/c	1.97	0.04	-5.23	0.06			
Se/04/-04/04	27400	6000	71.8				30.1	1.2	N6	N8	5b/c	2.43	0.03	-4.88	0.04			
Se/04/-03/04	27600	3000	95.3	54.1	41.2			3.18	N6	N8	6	2.63	0.02	-4.95	0.05			
Se/04/-02/04	27850	5000	9.3			2.4		0.19	N6	N8	5b/c	2.24	0.04	-4.71	0.04			
Se/04/-01/04	28100	5000	13.3					0.27	N7	N8	6	2.47	0.03	-3.02	0.03			
Se/04/01/04	28400	6500	35					0.54	N6	5YR8/1	2; 6	2.53	0.02	-3.34	0.03			
Se/04/02/04	28600	2000	20.5			1.8		1.03	N6	N8	6	2.12	0.03	-4.46	0.02			
Se/04/03/04	28800	4000	79.7					1.99	N7	N8	3a; + dolomite	2.79	0.03	-5.23	0.03			
Se/04/04/04	29000	3000	47.6					1.59	N7	N7	6	2.46	0.01	-5.04	0.04			
Se/04/05/04	29250	4000	23.6					0.59	N6	5Y8/1	6	2.52	0.02	-2.93	0.02			
Se/04/06/04	29450	2000	1.5					0.08	N5	5Y8/1	5b?; 6	2.33	0.03	-5.84	0.04			
Se/04/07/04	29650	4000	2.7					0.07	N7	5Y8/1	5b/c	2.50	0.03	-5.58	0.05			
Se/04/08/04	29850	2000	10.1					0.51	N7	N7	5b/c	2.49	0.03	-4.93	0.04			
Se/04/09/04	30050	5000	3.6					0.07	N6	5Y8/1	5b/c	2.30	0.04	-5.39	0.06			
Se/04/10/04	30250	2000	30.9					1.55	N6	N7	5b	2.45	0.04	-5.18	0.04			
Se/04/11/04	30450	2500	5.3					0.21	N6	5Y8/1	5b	2.48	0.03	-5.63	0.05			
Se/04/12/04	30750	2500	32			2.2		1.28	N5	N7	5b	2.12	0.04	-5.07	0.05			
Se/04/13/04	30950	2000	43			4		2.15	5YR6/1	5YR6/1	5c	2.35	0.02	-5.16	0.05			
Se/04/14/04	31200	2000	52.3					2.62	N6	N7	5b	2.03	0.04	-5.16	0.03			
Se/04/15/04	31450	3000	1.4					0.05	N6	N7	5b	2.31	0.01	-5.36	0.05			
Se/04/16/05	32050	2000	7.5	4.5	3			0.38	5YR4/1	5Y8/1	5b							
Se/05/01/05	32250	2500	27.9	17.2	10.7	7		1.12	N2	5YR4/1	5c							

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