Rivista Italiana di Paleontologia e Stratigrafia	volume 111	no. 3	4 pls.	pp. 413-437	December 2005

BRACHIOPODS FROM THE UPPER TRIASSIC REEF HABITATS OF THE NORTHERN CALCAREOUS ALPS (DACHSTEIN LIMESTONE, HOCHSCHWAB, AUSTRIA)

MILOŠ SIBLÍK [1], with contribution by GERHARD BRYDA [2]

Received: December 20, 2004; accepted: May 12, 2005

Key words: Brachiopods, Upper Triassic, Dachstein Limestone, Northern Calcareous Alps.

Abstract. Upper Triassic brachiopods from 2 localities in the reef Dachstein Limestone of the SE Hochschwab massif in Styria, Austria are systematically described and illustrated. About 900 variably preserved specimens belong to 28 species, representing thus the most diverse brachiopod fauna known from the North Alpine Dachstein Limestone. This indicates that brachiopods were common inhabitants of reef habitats during the Alpine Norian. *Oxycolpella*, *Sinucosta* and *Aulacothyropsis* are dominant. Seven brachiopod species are known from the Kössen Formation (Rhaetian). *Adygella biplicata* (Dagys) and Ladinian *Hungarispira loretzi* (Bittner) are the newcomers in the Nordalpine Dachstein Limestone. In addition to brachiopods, only some fragments of bivalves were found. Conodonts of the species *Epigondolella triangularis* (Budurov, 1972) indicate the Early Norian age.

Riassunto. Viene descritta una fauna a brachiopodi del Triassico superiore proveniente da due località della facies di scogliera del Calcare di Dachstein, nella parte sud-orientale del massiccio di Hochschwab in Stiria, Austria. I circa 900 esemplari che costituiscono la collezione appartengono a 28 specie, rappresentando la fauna più diversificata sinora nota nel Dachstein delle Alpi Calcaree Settentrionali. Questo sta ad indicare che i brachiopodi popolavano in modo diffuso gli ambienti di scogliera nelle Alpi durante il Norico. *Oxycolpella*, *Sinucosta* e *Aulacothyropsis* sono le forme dominanti. Sette specie sono già note nella Formazione di Kössen (Retico), mentre *Adygella biplicata* (Dagys) e la forma ladinica *Hungarispira loretzi* (Bittner) sono segnalati per la prima volta nel Dachstein delle Alpi Settentrionali. Oltre ai brachiopodi sono stati rinvenuti solo frammenti di bivalvi. Il rinvenimento di conodonti riferibili alla specie *Epigondolella triangularis* (Budurov 1972) indica il Norico inferiore.

Introduction

Geographical & geological setting

The Hochschwab massif is an extended, intensively karstified plateau that covers an area of approx. 500 square kilometres at the southern border of the Northern Calcareous Alps in upper Styria, Austria. The massif is a part of the Mürzalpen Nappe (Kristan-Tollmann & Tollmann 1962, Tollmann 1964) within the Upper Austroalpine nappe system of the Northern Calcareous Alps. By far the largest part of the massif consists of Middle Triassic Wetterstein platform limestones (lagoon-reef-front) and, to a smaller extent, basinal sediments (Grafensteig Fm.). In the region of the southeastern Hochschwab massif (Mitteralm, Karlhochkogel Mt.) north of the village of Aflenz, the remains of the Wetterstein platform with late diagenetic dolomitization and superimposed Carnian dark grey to black limestones with frequent calcisponges and intercalated brown shales (Leckkogel Fm.) represent the base of the Upper Triassic (Norian-Rhaetian) Dachstein platform. Within this platform a transition in facies zones can be observed from the lagoonal to reef and forereef Dachstein Limestone and to the basinal Aflenz Limestone. This virtually not dissected succession was the aim of a detailed investigation by Lobitzer (1971, 1975). He noticed that lenses of variegated, lutitic "Hallstatt type" limestones are frequently intercalated in the central Dachstein reef facies (Lobitzer 1971, p.

1 Dr. Miloš Siblík, Institute of Geology, Academy of Sciences of the Czech Republic, Rozvojová 135, CZ -165 00 Praha 6 - Suchdol. E-mail: siblik@gli.cas.cz.

2 Mag. Gerhard Bryda, Geological Survey of Austria, Neulinggasse 38, A-1030 Vienna. E-mail: gerhard.bryda@geolba.ac.at.

60), and that one of these lenses already described by Stur (1871), who found the cephalopod *Stenarcestes subumbilicatus* Bronn there, yielded Lower Norian conodont fauna. Lobitzer (1971, p. 181, p. 183) also described the frequent occurrence of cephalopod nests, bivalves and *Heterastridium conglobatum* (Reuss, 1865), which he interpreted as transported organisms from the near Aflenz Limestone basin.

Flügel (1981) compared the situation in the Hochschwab massif with several other Norian platform developments (e.g. Wand Limestone from the Hohe Wand at the eastern border of the Calcareous Alps in Lower Austria or Furmanec Limestone from the Slovak Carpathians).

All these platforms formed a depositional system that was open to and in close connection with the contemporaneous basinal facies.

Recent geological mapping of the Hochschwab area (Fig. 1, Bryda et al. 2002) revealed a complex system of compressive and divergent strike-slip duplexes that were generated during the lateral extrusion of the Eastern Alps (Ratschbacher et al. 1991) in the Miocene.

Many of the facies boundaries within the Dachstein platform of the southeastern Hochschwab massif are subparallel to NE-SW and E-W trending sinistral strike-slip faults that have a considerable lateral offset. This means that future investigations of the reef (Dachstein Limestone) to basin (Aflenz Limestone) transition have to take critical consideration of this circumstance.

The goal of the present paper is to describe in detail the diverse Norian brachiopod assemblage from the reef limestone of the Hochschwab. This is important, as there exist only few data on Norian brachiopods of the Alps, and our data enhance the understanding of the stratigraphical and environmental distribution of Norian brachiopod species and genera.

Previous data on brachiopods from the Hochschwab massif

Bittner gave the first detailed information on the brachiopods of the Dachsteinkalk from the Hochschwab massif in his monograph on the Triassic brachiopods (1890), where also several new species from the Dachsteinkalk were established. He mentioned "*Koninckina* spec. indet." and "*Halorella amphitoma* Bronn sp." from the "Hochgebirgskorallenkalk" of the Mitteralpe, "*Halorella curvifrons* Quenst. sp." from the cliffs of the Mitteralpe near the Fölzalm, and "*Spirigera eurycolpos* Bittn." from Festl-Beilstein Mt. (1847 m) near Buchberg. Moreover, he documented "*Rhynchonella* cfr. *Schönni* Bittn., *Rhynchonella Augusti* Bittn., *Rhynchonella* spec. indet., *Spirigera* cfr. *trigonella* Schloth. sp. and *Spiriferina* cfr. *halobiarum* Bittn." from the limestone with halobiids found below Hochstein Mt. From the area between Seewiesen and Aflenzer Staritzen, he mentioned his new species *Waldheimia (Aulacothyris) frontalis*. Spengler (1920), in his paper on stratigraphy and tectonics of the Hochschwab, extended the faunal list of Bittner with "*Rhynchonella* sp. indet. aff. *lingularis* Bittner" from Hochstein Mt. He held, however, Bittner's limestones of Hochstein Mt. as Wettersteinkalk. It is of interest that Spengler found megalodontid cross-sections in the lagoonal Dachsteinkalk near the top of the Karlhochkogel Mt. No brachiopod species from the Dachstein Limestone of Hochschwab have been mentioned in literature since time of Bittner and Spengler.

New data on brachiopods from the southeastern Hochschwab massif.

Brachiopods are an important constituent of the Late Triassic fauna of the Dachstein Limestone in the SE part of the Hochschwab massif, Styria. This paper is based on material collected by the authors in the years 1998 – 2001. Brachiopod-bearing rocks were ascertained during geological mapping at 2 localities. Both localities are situated within the central reef facies of Lobitzer (1971) (see sketch map in Fig. 1 for details). First samples were collected by Bryda on the slope of the Karlhochkogel Mt. (2096 m) and by Kreuss near the Fölzalm. Systematic sampling by one of the co-authors (M. S.) followed at both places in the years 1998-2001. More than 900 specimens of brachiopods were sampled and deposited in the Institute of Geology ASCR in Prague (HO 001- 923). The figured ones are housed in the collections of the Geological Survey in Vienna (GBA 2004/2/01-30).

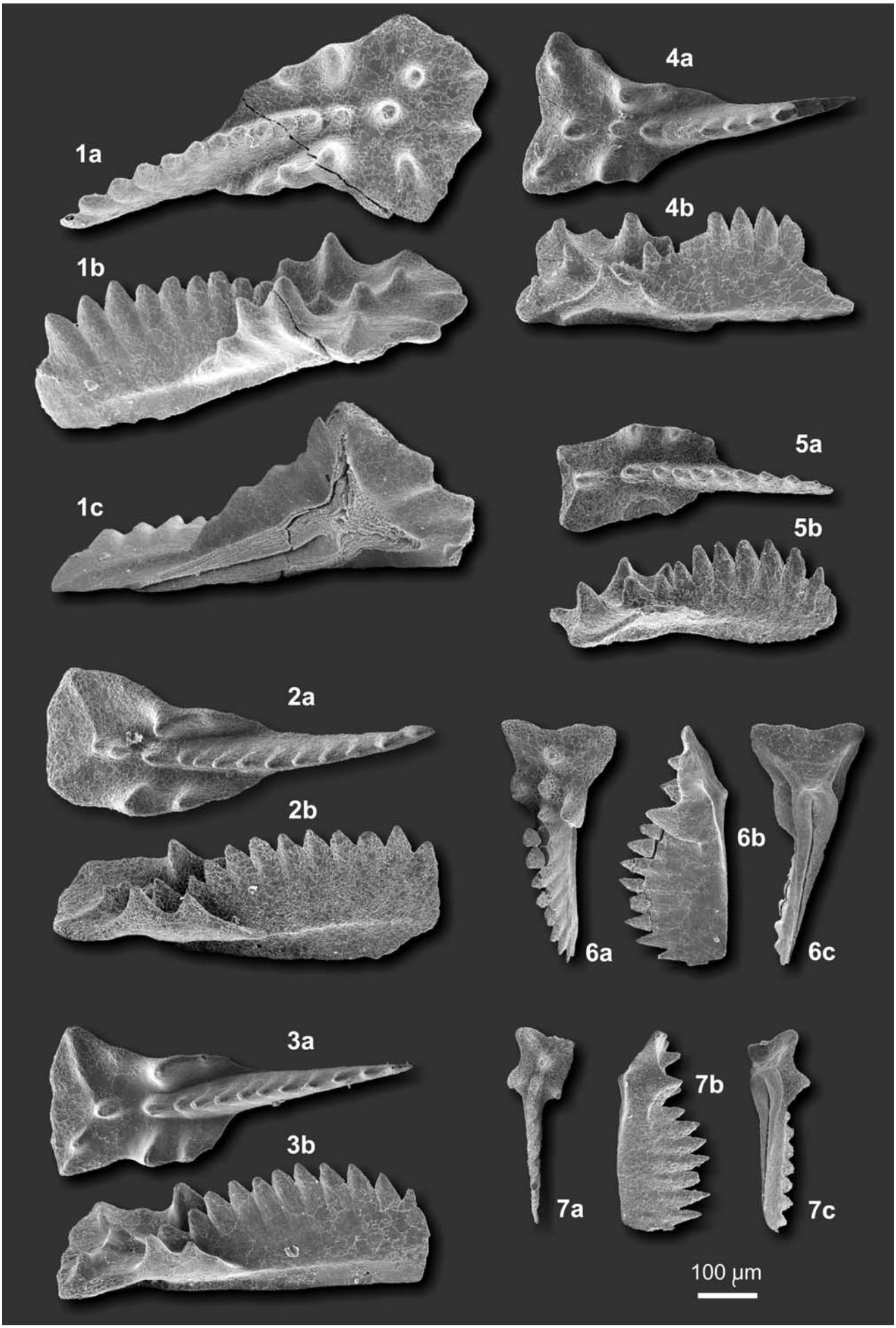
Localities

Most brachiopod specimens were collected in the shell enrichments of massive karstified limestones on the eastern slope of Karlhochkogel Mt. (lat. 47° 36' 25.6" – long. 15° 9' 43.7" WGS84). Brachiopods were embedded in fine grained to micritic, light grey types of the Dachstein Limestone with frequent crinoidal fragments. Accompanying macrofauna contained fragmen-

PLATE 1

Conodonts from the brachiopod locality in the Dachstein Limestone of Karlhochkogel.

Fig. 1 - 7 - Various growth stages of *Epigondolella triangularis* (Budurov). Lower Norian (Lacian 2 / III). a = upper view, b = lateral view, c = (oblique) lower view
Sample Siblík, determination Krystyn, preparation and computer graphics for the plate Mandl, microphotos Priewalder.


1a
1b
1c
2a
2b
3a
3b
4a
4b
5a
5b
6a
6b
6c
7a
7b
7c
100 µm

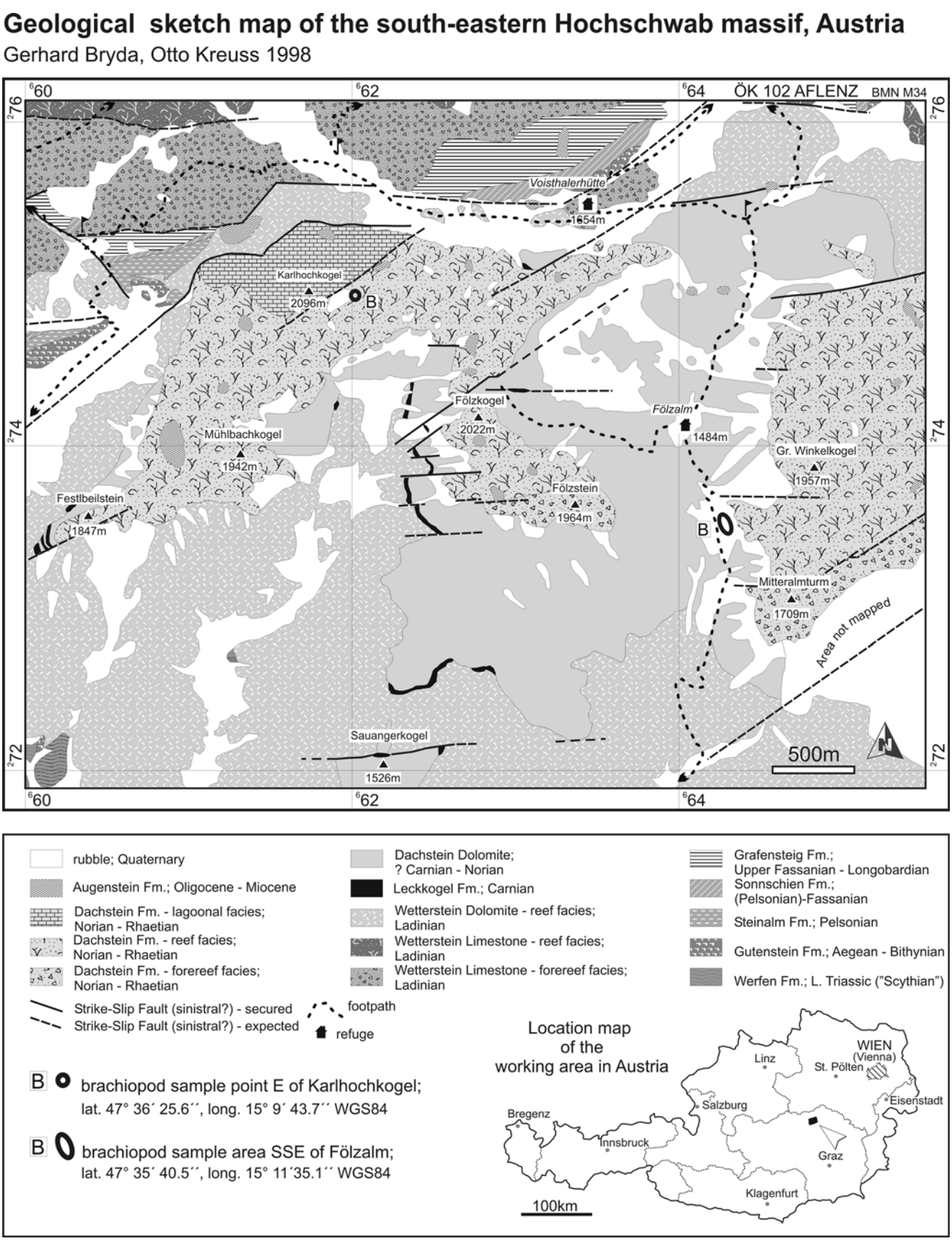


Fig. 1 - Geological map of the SE Hochschwab massif (Bryda & Kreuss 1998) with the brachiopod localities.

tary, poorly preserved bivalves. Conodonts were found in one sample only. This sample yielded several specimens of *Epigondolella triangularis* (Budurov, 1972) pointing to the Early Norian (Upper Lacian 2) age. This information is comparable with that already known but unpublished by Lobitzer (1971). The conodont material was prepared by Mandl and determined by Krystyn (Pl. 1).

The second locality SSE Fölzalm (1484 m) lies below the Gr. Winkelkogel Mt. (1957 m), which is situated in the western part of the Mitteralpe, in the large debris field (47° 35' 40.5" – 15° 11' 35.1" WGS84). According to Lobitzer (1971, p.94), inozoan sponges dominate in the central reef facies of the Mitteralpe. Sphinctozoans and corals are of secondary importance. Brachiopods were found in fallen blocks of the same type of reef limestones as at Karlhochkogel Mt. (probably from "nests" or fissure fillings in the steep mountain walls).

Preservation of the material

A high proportion of the collected specimens were fragmentary and therefore unsuitable for measurements. Because of severe recrystallisation, the material was not ideally preserved for sectioning. Therefore, due to the limited amount of available specimens only some taxa were sectioned in order to investigate internal features.

It is of interest to notice that shells of *Oxycolpella eurycolpos*, due to their dark coloured shells, could be easily recognized even in the rock fragments. Carbon was the only element to cause the dark to black colour of the shells, as was proven by the energy dispersive analysis made by Mrs. A. Langrová (EDAX PV 9400 spectrometer in the Institute of Geology, Academy of Sciences, Prague).

Brachiopods identified from our recent collection:

Karlhochkogel: "*Rhynchonella*" aff. *misella* Bittn., *Norella guttula* (Bittn.), *Fissirhynchia fissicostata* (Suess), *Oxycolpella eurycolpos* (Bittn.), ?*Tetractinella* sp., *Neoretzia superba* (Suess), *Hungarispira loretzi* (Bittn.), *Schwagerispira fastosa* (Bittn.), *Amphiclina intermedia* Bittn., *Amphiclina*? sp., *Laballa suessi* (Zugm.), *Zugmayerella koessenensis* (Zugm.), *Mentzelia* sp., *Mentzelioides* cf. *budensis* (Hoffm.), *Sinucosta emmrichi* (Suess), *Sinucosta* cf. *bittneri* (Dagys), *Adygella biplicata* Dagys, *Rhaetina pyriformis* (Suess), *Rhaetina* sp., ?"*Terebratula*" *sturi juvavica* Bittn., "*Terebratula*" sp., juv.(?), *Lobothyris* cf. *praepunctata* (Bittn.), *Aulacothyris* aff. *telleri* Bittn., *Gemerithyris* aff. *zugmayeri* (Bittn.), *Zeilleria austriaca* (Zugm.) and *Aulacothyropsis* ex gr. *reflexa* (Bittn.).

Fölzalm: *Halorella amphitoma* (Bronn) and *Halorelloidea rectifrons* (Bittn.).

Systematic description (Siblík)

Order **Rhynchonellida** Kuhn, 1949

Superfamily Dimerelloidea Buckman, 1918

Family Halorellidae Ager, 1965

Halorella Bittner, 1884

Halorella amphitoma (Bronn, 1832)

Pl. 2, figs 7-8

1832 *Terebratula amphitoma* Bronn, p.162.
1832 *Terebratula pedata* Bronn, p. 163.
1890 *Halorella amphitoma* – Bittner, p. 183, 230, pl. 16, fig. 29-30, pl. 18, fig. 3-9, pl. 19, fig. 1-25, pl. 20, fig. 1-19.
1890 *Halorella pedata* – Bittner, p. 179, pl. 17, fig. 1-20.
1957 *Halorella amphitoma* - Mahel', p.163, pl. 5, fig. 1-2.
1958 *Halorella amphitoma* - Mahel', p. 134, pl. 5, fig. 1-2.
1963 *Halorella amphitoma* - Dagys, p. 54, pl. 5, fig. 8-12, pl. 6, fig. 1-12, text-fig. 17-19 (cum syn.).
1965 *Halorella amphitoma* - Dagys, p. 89, pl. 12, fig. 5-6 (cum syn.).
1978 *Halorella amphitoma* - Ager et al., p. 62, pl. 1, fig. 4, text-fig. 17-19.
1988 *Halorella amphitoma* - Siblík, p. 32 (cum syn.).

Material: 18 damaged shells, 17 brachial and 46 pedicle valves, up to 39.0 mm in length, 41.5 mm in width and 27.0 mm in thickness (HO 161-241). The figured specimen (Pl. 2, fig. 8, HO 241-GBA 2004/2/8) has dimensions 21.0 x 20.0 x 15.5 mm.

Description and remarks. Detailed descriptions of this species, characterized by high morphologic variation, were given already by Bittner (1890) and by Dagys (1963). Bittner (1890) established several morphotypes of Bronn's *T. amphitoma* and *T. pedata*. Dagys (1963) considered both Bronn's species to be synonymous and this view was later followed also by Siblík (1988). The specimens from Hochschwab have 8-26 coarse ribs on valve. Slight sulcations on both valves are perceptible in several specimens. A very low uniplication is visible in 4 specimens. Ciliform crura and absence of septum characterize the interiors.

Range. Norian, in Turkey also Upper Carnian.

Distribution. Fölzalm. Austria, Bavaria, Slovakia, Hungary, Bulgaria, Romania, Italy, Turkey, Siberia, Pamir, Indonesia, ? China, USA.

Halorelloidea Ager, 1960

Halorelloidea rectifrons (Bittner, 1884)

Pl. 2, fig. 11

1884 *Halorella rectifrons* Bittner, p. 107.
1890 *Halorella rectifrons* nov. spec. - Bittner, p. 187, pl. 21, fig. 31-52, Pl. 22, fig. 1-36.
1963 *Halorelloidea rectifrons* - Dagys, p. 60, text-fig. 21-24, pl. 7, fig. 4-9.
1988 *Halorelloidea rectifrons* - Siblík, p. 34 (cum syn.).

Material: 15 small partially damaged, probably juvenile specimens (HO 263-277). The complete specimens measure 7.2 x 9.5 x 3.6 mm (figured, HO 270-GBA 2004/2/11) and 6.8 x 8.6 x 3.4 mm (HO 265).

Remark. External and internal morphologic variation of this species was described in detail by Bittner (1890) and by Dagys (1963).

Range. Norian.

Distribution. Fölzalm. Austria, Bavaria, Slovakia, Hungary, Romania, Italy, Pamir, ? Indonesia.

Superfamily Rhynchonelloidea d'Orbigny, 1847

Family Rhynchonellidae d'Orbigny, 1847

Subfamily Rhynchonellinae d'Orbigny, 1847

Rhynchonella Fischer, 1809; s.l.

"**Rhynchonella**" aff. **misella** Bittner, 1890

Pl. 2, fig. 9

aff. 1890 *Rhynchonella misella* Bittner, p. 267, pl. 24, fig. 17.

? 1890 *Rhynchonella* spec. indet. – Bittner, p. 267, pl. 40, fig.16 (in the plate as *Rhynchonella* aff. *lingularis*).

Material: 2 specimens. Their dimensions are 8.7 x 7.0 x 3.8 mm (figured, HO 278-GBA 2004/2/9) and 6.5 x 5.0 x 3.3 mm (HO 279).

Description and remarks. Both small semicostate specimens show considerable resemblance to *Rhynchonella misella*, which was established by Bittner (1890) and based on 1 specimen known only. However, they are less convex and ventral beak is straight. In addition, they have only 3 subrounded ribs on low fold. Similarly as in *R. misella*, the ribs are visible only near sharpened anterior margin in our material. Bittner (1890) described another similar rhynchonellid from the Dachstein Limestone of Hochschwab as *Rhynchonella* spec. indet. It has much larger outline and linguiform high plication in anterior commissure, with suggestion of 2 incipient ribs. Scarcity of our material makes any more detailed comparison difficult for present. Other small Upper Triassic rhynchonellids differ from our material mainly in greater convexity of valves, in different character of ribbing and in linguiform shape of anterior plication.

Range. "*Rhynchonella*" *misella* was described from the „Hochgebirgskorallenkalk" (? Norian). Its exact stratigraphic range is unknown.

Distribution. Karlhochkogel. Bittner's species is known from its type locality only (Putzenköpfl near Hallein - Dürrnberg, Salzburg).

Superfamily Norelloidea Ager, 1959

Family Norellidae Ager, 1959

Subfamily Norellinae Ager, 1959

Norella Bittner, 1890

Norella guttula (Bittner, 1890)

Fig. 2, Pl. 4, fig. 8

1890 *Rhynchonella guttula* Bittner, p. 268, pl. 24, fig. 19.

1988 *Norella guttula* - Siblík, p. 43.

Material: 8 shells (HO 280-287). The best preserved specimens measure: 8.0 x 7.5 x 5.4 mm (figured, HO 282-GBA 2004/2/28), 6.8 x 7.3 x 5.3 mm (HO 285) and 6.7 x 6.6 x 4.8 mm (HO 286, sectioned).

Description. Minute globose shells, unisulcate, smooth, mostly equibiconvex. Outline round, lateral commissures straight, linguiform extension of anterior commissure variably deep, sulcus of brachial valve shallow and not sharply delimited, beak small and short, incurved, beak ridges short and poorly developed. Posterior thickening stronger in the pedicle valve. No pedicle collar observed. Dental lamellae very short, convergent ventrally. Straight hinge teeth without crenulation, accompanied in some specimens with strongly developed squat denticula. Large sockets. Hinge plates fused and subhorizontal. Neither septalium nor septum or septal ridge in brachial valve. Pedicle valve with strongly developed median ridge. Crura fairly long, arcuifer-type.

Remark. Most of our specimens are practically identical with the specimen figured by Bittner, with the only difference that they develop deeper anterior sinus.

Range. The species was described from the "Salzburger Hochgebirgskorallenkalk" (? Norian) and based only on several poorly preserved specimens. The present study shows definitely their Early Norian age.

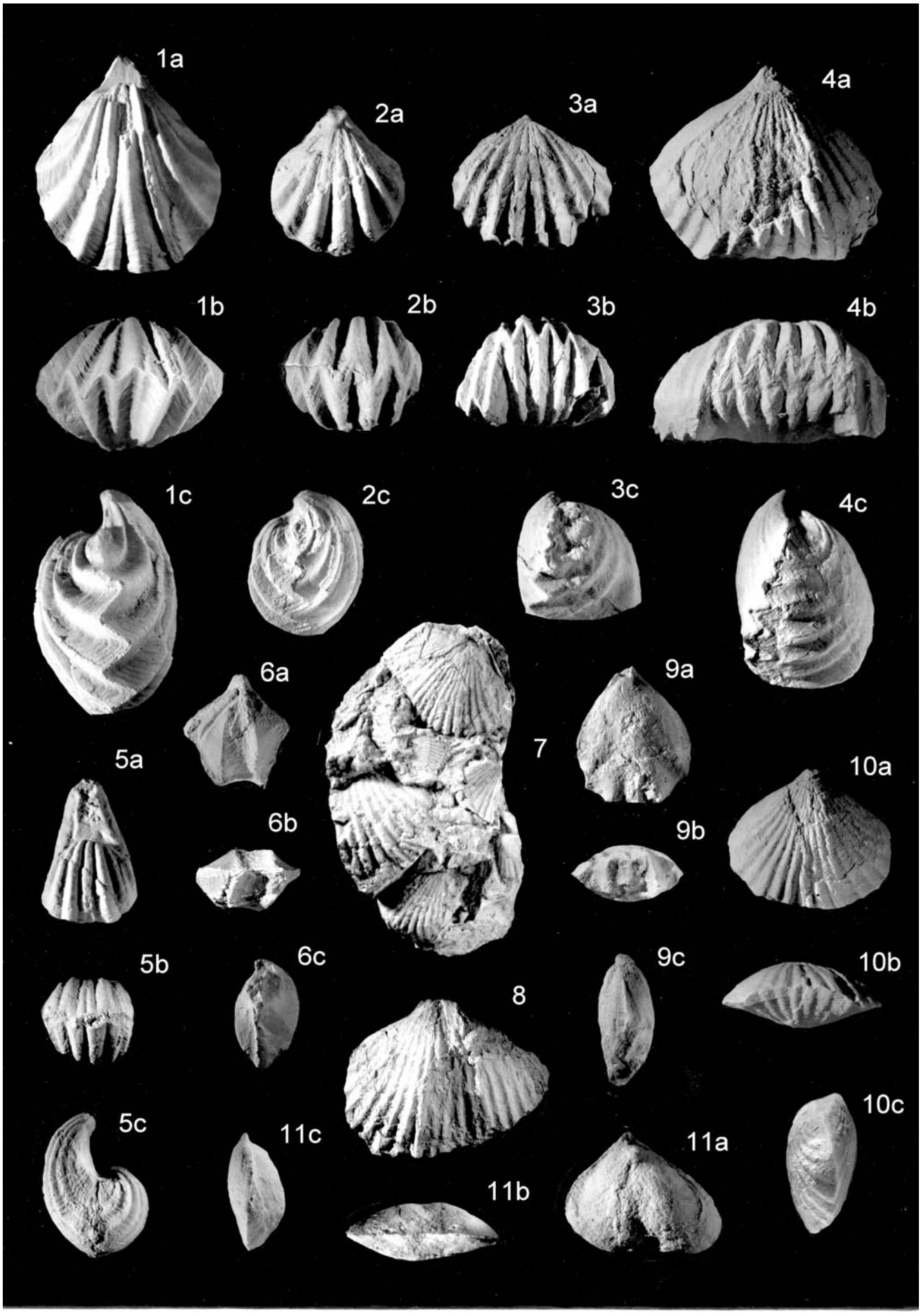
Distribution: Karlhochkogel. Putzenköpfl near Dürrnberg/Hallein, Salzburg (type locality).

PLATE 2

All figures in the Plates 2-4 by J. Brožek, Prague (the specimens coated with ammonium chloride before photographing). They are deposited in the collections of the Geologische Bundesanstalt in Vienna (GBA 2004/2/1-30)

Specimens in Pl. 2 are from Karlhochkogel except figs. 7-8 and 11 from Fölzalm.

Fig. 1 - *Neoretzia superba* (Suess). GBA 2004/2/1, x 2.
Fig. 2 - *Schwagerispira fastosa* (Bittner). GBA 2004/2/2, x 3.
Fig. 3 - *Fissirhynchia fissicostata* (Suess). GBA 2004/2/3, x 2.
Fig. 4 - *Fissirhynchia fissicostata* (Suess). GBA 2004/2/4, x 2.
Fig. 5 - *Hungarispira loretzi* (Bittner). GBA 2004/2/5, x 3.
Fig. 6 - ? *Tetractinella* sp. GBA 2004/2/6, x 2.
Fig. 7 - *Halorella amphitoma* (Bronn). GBA 2004/2/7, x 1.
Fig. 8 - *Halorella amphitoma* (Bronn). GBA 2004/2/8, x 1.
Fig. 9 - *"Rhynchonella"* aff. *misella* Bittner. GBA 2004/2/9, x 3.
Fig. 10 - *Fissirhynchia fissicostata* (Suess). GBA 2004/2/10, x 2.
Fig. 11 - *Halorelloidea rectifrons* (Bittner). GBA 2004/2/11, x 3.


1a
2a
3a
4a
1b
2b
3b
4b
1c
2c
3c
4c
6a
9a
5a
7
10a
6b
9b
5b
6c
9c
10b
8
5c
11c
10c
11a
11b

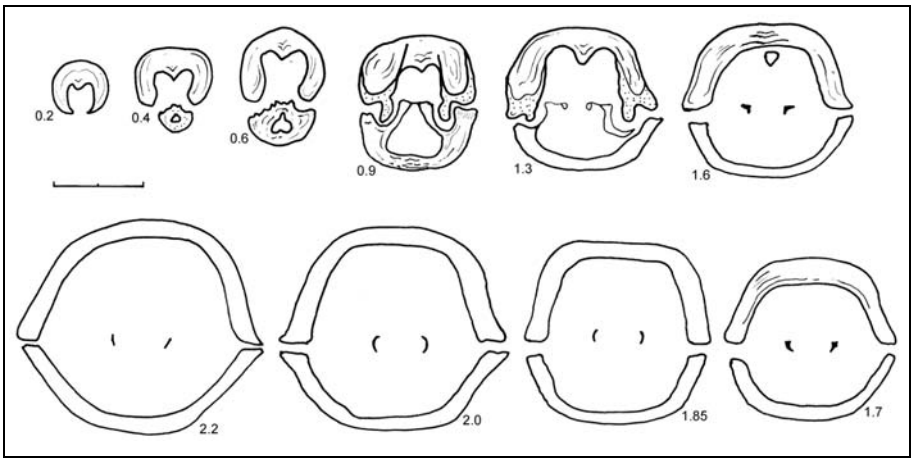


Fig 2 - *Norella guttula* (Bittner). Karlhochkogel. HO 286. Original length 6.7 mm. Serial transverse sections through the posterior part of shell. No dorsal septum. Enlarged, bar equals 2 mm. Another specimen showed a pedicle collar. Cumulative spacings given in mm from the pedicle beak.

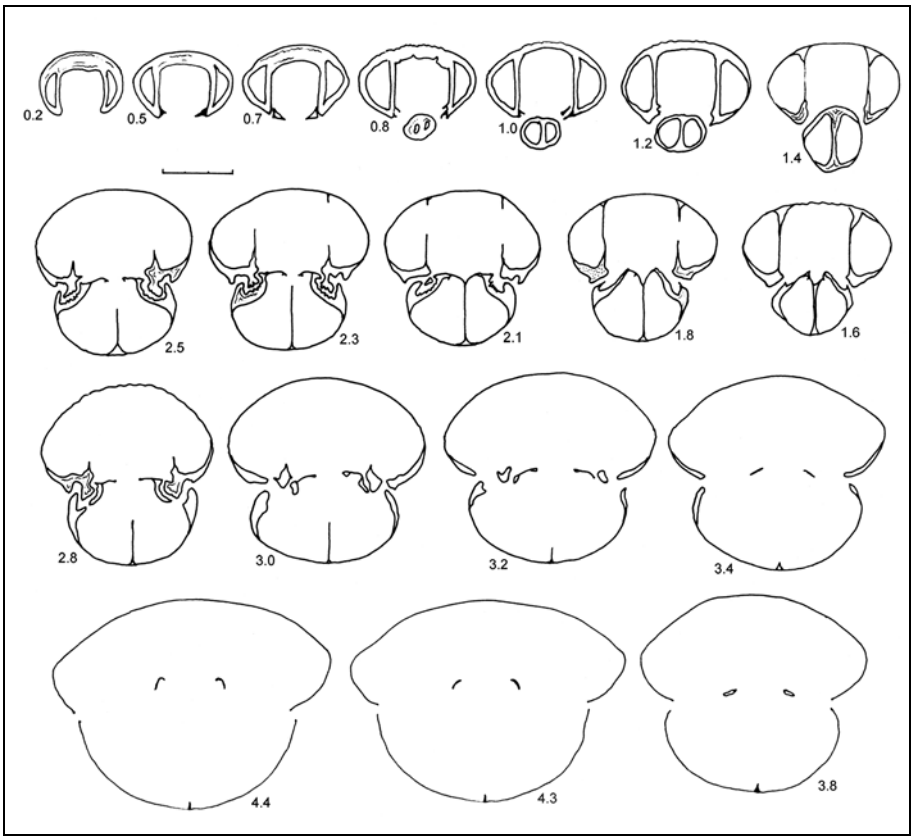


Fig 3 - *Fissirhynchia fissicostata* (Suess). HO 291. Karlhochkogel. Original length 18.0 mm. Well-developed denticula in the sections 2.1-2.8. Median ridge disappeared at 5.0 mm from the posterior end. Magnified, bar equals 3 mm. Another specimen showed ventrally divergent dental lamellae.

Superfamily Hemithiridoidea Rzhonsnitskaia, 1956

Family Cyclothyrididae Makridin, 1955

Subfamily Cyclothyridinae Makridin, 1955

Fissirhynchia Pearson, 1977

Fissirhynchia fissicostata (Suess, 1854)

Fig. 3, Pl. 2, figs 3-4, 10

1854 *Rhynchonella fissicostata* Suess, p. 58, pl. 4, fig. 1-4.

1957 *Rhynchonella fissicostata* - Mahel', p. 157, pl. 3, fig. 1-3.

1963 *Septaliphoria fissicostata* - Dagys, p. 50, pl. 3, fig. 7-11, text-fig. 15-16.

1977 *Fissirhynchia fissicostata* - Pearson, p. 48, pl. 6, fig. 1-10, text-fig. 17-19 (cum syn.).

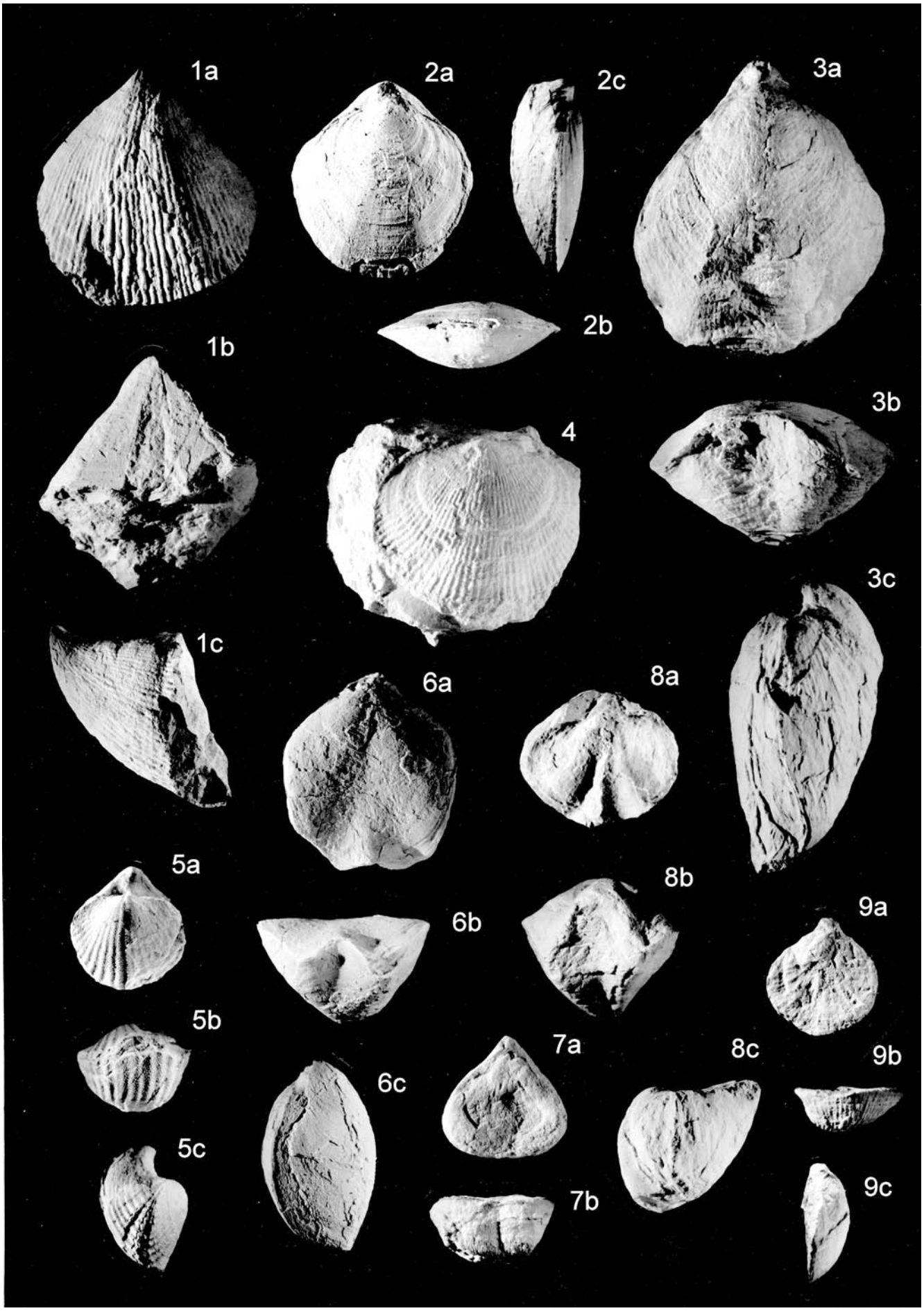
1978a *"Rhynchonella" fissicostata* - Iordan, pl. 1, fig. 7, 9.

1978b *"Rhynchonella" fissicostata* - Iordan, p. 49, pl. 1, fig. 1.

PLATE 3

All specimens are from Karlhochkogel.

Fig. 1 - *Sinucosta emmrichi* (Suess). Pedicle valve. GBA 2004/2/12, x 1.5.
Fig. 2 - *Zeilleria austriaca* (Zugmayer). GBA 2004/2/13, x 1.5.
Fig. 3 - *Oxycolpella eurycolpos* (Bittner). GBA 2004/2/14, x 1.5.
Fig. 4 - *Sinucosta emmrichi* (Suess). Brachial valve. GBA 2004/2/15, x 1.5.
Fig. 5 - ? *Sinucosta emmrichi* (Suess), juv. GBA 2004/2/16, x 2.
Fig. 6 - *Gemerithyris* aff. *zugmayeri* (Bittner). GBA 2004/2/17, x 2.
Fig. 7 - *Amphiclina intermedia* Bittner. GBA 2004/2/18, x 2.
Fig. 8 - *Laballa suessi* (Zugmayer). GBA 2004/2/19, x 1.5.
Fig. 9 - *Amphiclina*? sp. GBA 2004/2/20, x 2.


1a
2a
2c
3a
2b
1b
3b
4
3c
1c
6a
8a
5a
8b
6b
9a
5b
7a
8c
9b
6c
5c
7b
9c

1978c *"Rhynchonella" fissicostata* - Iordan in Bordea et al., p. 69, pl. 1, fig. 3-4.

1988 *Fissirhynchia fissicostata* - Siblík, p. 56, pl. 2, fig.6 (cum syn.).

2001 *Fissirhynchia fissicostata* - Siblík, p. 17 (cum syn.).

Material: 70 shells, preserved as partly decorticated and mostly fragmentary internal moulds up to 20.0 mm in length, 25.5 mm in width and 16.0 mm in thickness (HO 289-358). The figured specimens have following dimensions: 13.5 x 15.4 x 10.1 mm (HO 320-GBA 2004/2/3, Pl. 2, fig. 3), 18.8 x 21.8 x 12.0 mm (HO 331-GBA 2004/2/4, Pl. 2, fig. 4) and 13.5 x 15.4 x 6.5 mm (HO 335-GBA 2004/2/10, Pl. 2, fig. 10). Complete sectioned specimens measured 18.0 x 24.2 x 15.1 mm (HO 291, Text-fig. 3) and 17.6 x 21.1 x 13.1 mm (HO 300).

Description and remarks. Dagys (1963) and Pearson (1977) gave thorough descriptions of this well-known species and discussed its external variability. This large variability can be found also in our material, and it concerns above all outline and lateral profile of shell, width and height of anterior plication, and character of ventral beak. Anterior plication is in several specimens very high. Fold of brachial valve is raised, approaching a cynocephalous condition (Pl. 2, fig. 3). Number of ribs on valve varies from 12 (exceptionally) to 28. Anterior uniplication involves from 4 (in 16 specimens) or 5 (32 specimens) to 8 (in 1 specimen) sharp ribs. Ventral beak is mostly inclined to suberect. In this respect, specimens from Hochschwab are similar to those figured by Mahel' (1957, 1958) from the Stratenská hornatina Mts. and by Dagys (1963) from Caucasus. In contrast to them, *Fissirhynchia fissicostata* from the Kössen Formation figured by Pearson (1977) is broader and its beak is erect and massive. Well-developed bifurcation of ribs is ascertainable only in some specimens from Hochschwab. Serial sections of the figured specimen (HO 291, Fig. 3) showed absent pedicle collar, well-developed deltidial plates, subparallel dental lamellae, strong crenulated hinge teeth, blunt denticula, large crenulated sockets with better developed outer socket ridges, subhorizontal hinge plates, small septalium, thin dorsal septum and canaliform crura. Other sectioned specimens revealed no septalium and only short and low dorsal septum. The same characters of high septum and of septalium as shown in Fig. 3 can be found in the specimen from the NW Caucasus figured by Dagys (1963) in his fig. 15. On the contrary, the specimens figured by Pearson from Lower Austria (1977, text-fig. 17-18) were characterized by the presence of low septum and poor development of septalium.

Range. Norian - Rhaetian. The data, which reported occurrence of this species in the Lower Liassic deposits, were not confirmed.

Distribution. Karlhochkogel. Austria, Bavaria, Slovakia, Ukrainian Carpathians, Switzerland, Hungary, Romania, Bulgaria, Italy, Turkey, Crimea, Caucasus, Iran.

Order **Athyridida** Boucot, Johnson & Staton, 1964

Suborder **Athyrididina** Boucot, Johnson & Staton, 1964

Superfamily Athyridoidea Davidson, 1881

Family Diplospirellidae Schuchert, 1894

Subfamily Clavigerinae Waterhouse, 1975

Oxycolpella Dagys, 1962

Oxycolpella eurycolpos (Bittner, 1890)

Figs. 4-6, Pl. 3, fig. 3

1890 *Spirigera eurycolpos* Bittner, p. 273, pl. 29, fig. 7-14.

1957 *Spirigera eurycolpos* - Mahel', p. 169, pl. 6, fig. 3-10, pl. 7, fig. 1.

1958 *Spirigera eurycolpos* - Mahel', p. 140, pl. 6, fig. 3-10, pl. 7, fig. 1.

1978a *Oxycolpella eurycolpos* - Iordan, pl. 3, fig. 3.

1988 *Oxycolpella eurycolpos* - Siblík, p. 80.

1993 *Oxycolpella eurycolpos* - Iordan, pl. 2, fig. 14.

Material: 160 mostly fragmentary internal moulds with shell remains, up to about 44.0 mm in length, 38.5 mm in width and 26.0 mm in thickness (HO 001-159). The figured specimen (HO 112-GBA 2004/2/14) measures 36.4 x 30.4 x 18.7 mm. The sectioned specimen (HO 018) had the dimensions 32.5 x 24.8 x 16.4 mm.

Description. Outline of our specimens varies from subtrigonal, subpentagonal to rounded. Length greater than width and thickness. Brachial valve flatter in most specimens. Fold with shallow sulcation or medial flattening. Deep sulcus in the pedicle valve traceable towards umbo. Strong anterior uniplication broad to angular. Nearly rectimarginate specimens rarely present. Massive, strongly incurved ventral beak and extremely thick shell around the umbo are characteristic features of the species. Coarse growth lines well developed in the external parts of valves. Extremely thick shell, lateral umbonal cavities filled with secondary calcite, subparallel dental lamellae, massive hinge teeth freely inserted in wide but shallow sockets and thick bilobed cardinal process.

Remarks. With exception of Bittner (1890) and Mahel' (1957, 1958), there are no detailed descriptions of this species. It is the commonest brachiopod at Karlhochkogel, showing only minor differences in external morphology. This was observed also by Bittner (1890) who figured specimens of different dimensions and outlines. With regard to the extreme variability of external characters in oxycolpellids, it is difficult to differentiate *O. eurycolpos* from some similar morphotypes of *O. guseriplica* Dagys, 1962, *O. robinsoni* Dagys, 1962 and *O. kunensis* Dagys, 1963 from the Norian and Norian – Rhaetian deposits of the Caucasus. The type species of *Oxycolpella* – *O. oxycolpos* (Suess, 1854) from the Alpine Kössen Formation can be distinguished from *O. eurycolpos* by its substantially greater dimensions, by transversally oval outline and by absence of dorsal sulcation.

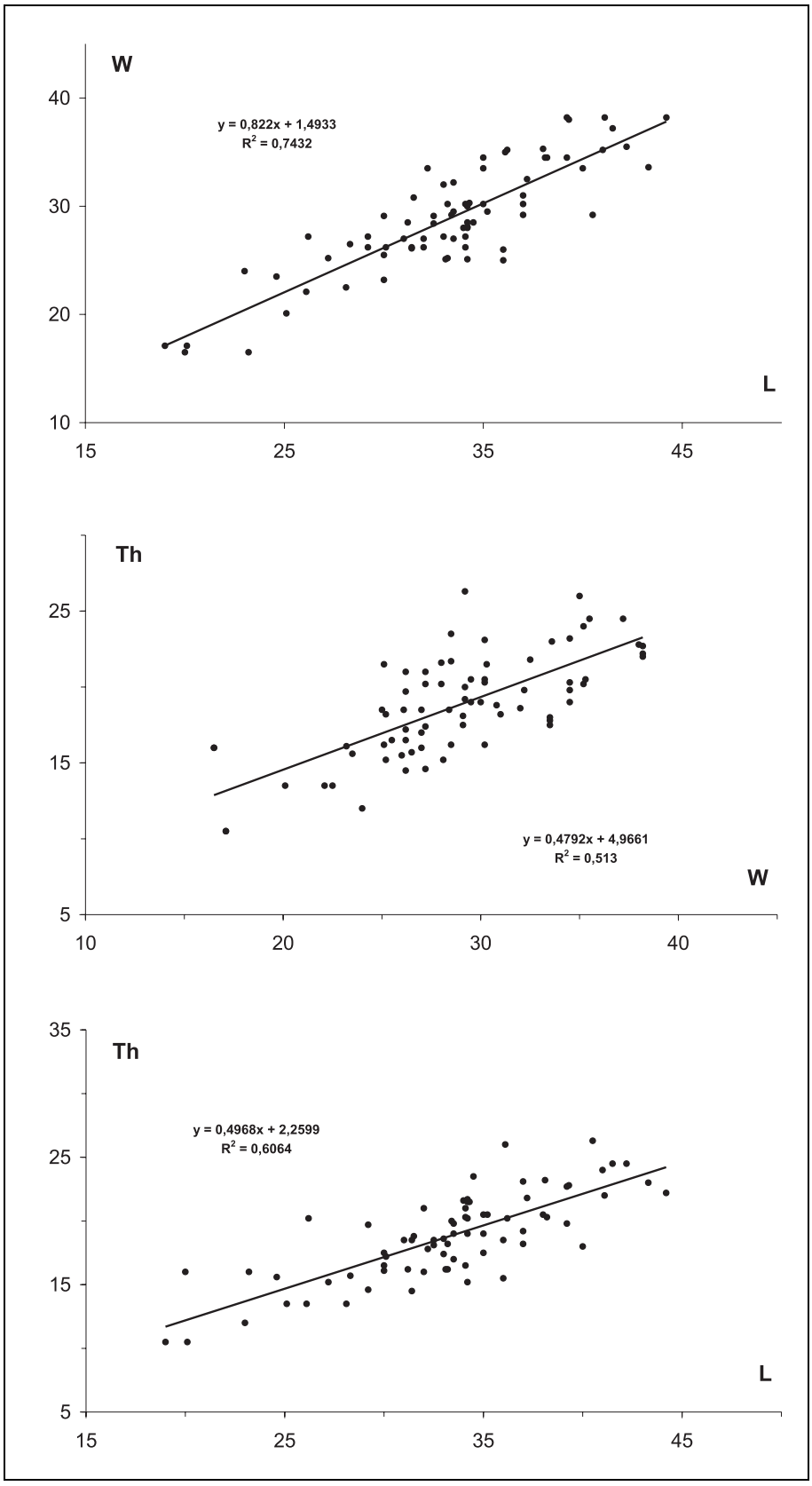


Fig 4 - *Oxycolpella eurycolpos* (Bittner). Karlhochkogel. Width-length, thickness-width and thickness-length scattergrams (in mm) for 74 well-preserved specimens.

Range. Norian. According to Pearson (1977, p. 34) the species does not cross the Norian/Rhaetian boundary.

Distribution. Karlhochkogel. Austria, Slovakia, Romania, Hungary, ?China.

Subfamily Tetractinellinae Grunt, 1986

Tetractinella Bittner, 1890

? Tetractinella sp.

Pl. 2, fig. 6

? 1890 *Spirigera* cfr. *trigonella* - Bittner, p. 274, pl. 40, fig. 20-21.

Material: 1 specimen (HO 840-GBA 2004/2/6) with dimensions 10.2 x 9.9 x 5.7 mm.

Description. Slightly ventri-biconvex punctate shell of sharply pentagonal outline. Maximum width situated in mid-length. Two conspicuous carinae extending from anterior margin right to umbos in corresponding position. Two posterolateral ribs rounded, well delimiting slightly concave planareas. Anterior commissure straight. Ventral beak strong and erect in position, foramen incomplete. Growth lines absent. - Internal characters unknown.

Remarks. The general shape and some external features of our specimen may remind one of the Middle Triassic *Tetractinella trigonella* (Schlotheim, 1820). Both specimens figured by Bittner (1890) from Hochschwab as *Spirigera* cfr. *trigonella* seem to be more closely allied to Schlotheim's species than our specimen having different outline with maximum width in anterior half, and 4 sharper ribs on each valve. Without knowledge of the internal structure is the definite generic attribution of our specimen not possible. It is important to note that *Tetracti-*

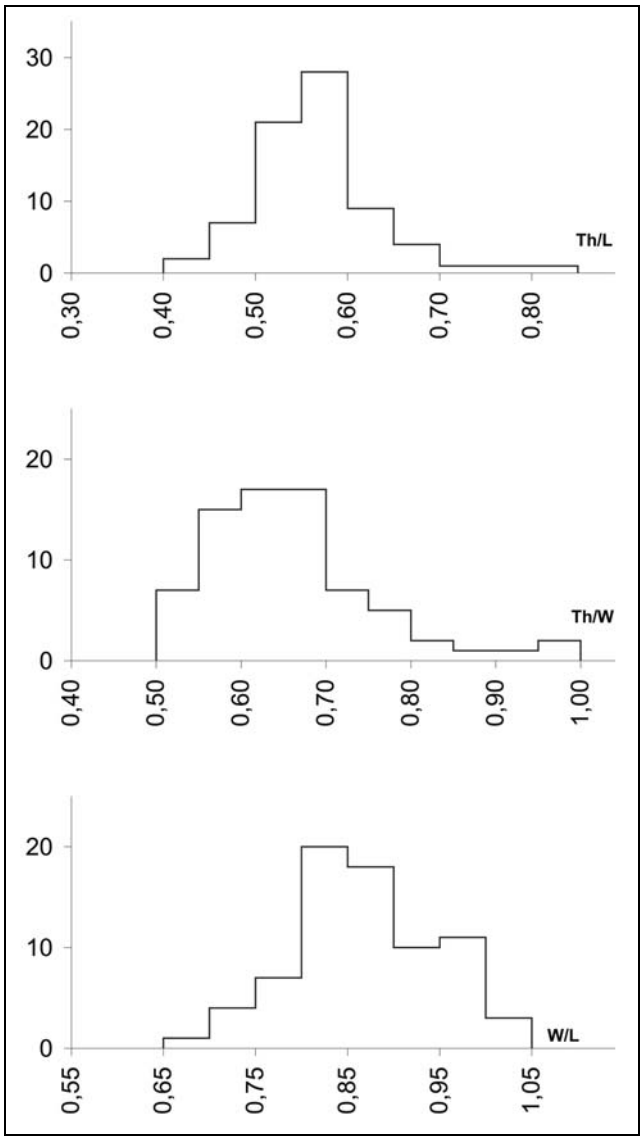


Fig 5 - *Oxycolpella eurycolpos* (Bittner). Thickness-length, thickness-width and width-length frequency histograms for 74 well-preserved specimens. Vertically number of specimens.

nella has impunctate shells (see the very detailed study of internal characters and ultrastructure of *Tetractinella* published recently by Mantovani (2002)).

Distribution. Karlhochkogel.

Suborder **Retziidina** Boucot, Johnson & Staton, 1964

Superfamily Retzioidea Waagen, 1883

Family Neoretziidae Dagys, 1972

Subfamily Neoretziinae Dagys, 1972

Neoretzia Dagys, 1963

Neoretzia superba (Suess, 1856)

Pl. 2, fig. 1

1856 *Waldheimia superba* Suess in Davidson, p. 48, pl. 1, fig. 7.

1890 *Retzia superbescens* Bittner, p. 281, pl. 26, fig. 13-15.

1957 *Retzia superbescens* - Mahel', p. 171, pl. 5, fig. 5-7.

1958 *Retzia superbescens* - Mahel', p. 143, pl. 5, fig. 5-7.

1963 *Neoretzia superbescens* - Dagys, p. 131, pl. 20, fig. 4-10, pl. 21, fig. 1-2.

1977 *Neoretzia superba* - Pearson, p. 29, pl. 2, fig. 11-16, text-fig. 8.

1977a *Neoretzia superbescens* - Iordan, pl. 3, fig. 7-8.

1988 *Neoretzia superba* – Siblík, p. 88, pl. 2, fig. 5 (cum syn.).

1993 *Neoretzia superbescens* - Iordan, pl. 2, fig. 16.

Material: 19 mostly fragmentary shells, 2 brachial and 5 pedicle valves, ranging up to 22.0 mm in length, 19.5 mm in width and 15.5 mm in thickness (HO 359-384). The figured specimen measures 21.7 x 17.4 x 13.4 mm (HO 370-GBA 2004/2/1).

Description and remarks. Our material is in accord with the detailed descriptions of both external and internal features given by Dagys (1963, p. 131 under *Neoretzia superbescens*) and by Pearson (1977, p. 29). In 18 specimens the bifurcation or trifurcation of the ribs is ascertainable in anterior half of valve. The ribs bordering low but clearly delimited fold of brachial valve are higher and stronger than the medium ones (1-3 in number). *Retzia superbescens* Bittner, 1890, which was distinguished from *N. superba* by absence of dichotomous ribbing, is included here into the synonymy of *N. superba* following Pearson (1977). He refused the difference based on the absence of dichotomous ribs only. He showed that presence or absence of dichotomous ribbing is a variable feature in *Neoretzia superba* itself.

Range. Norian, Rhaetian (Dachstein Limestone, Kössen Formation).

Distribution. Karlhochkogel. Austria, Slovakia, Romania, Iran, ?China.

Subfamily Hungarispirinae Dagys, 1972

Hungarispira Dagys, 1972

Hungarispira loretzi (Bittner, 1890)

Pl. 2, fig. 5

1890 *Retzia loretzii* Bittner, p. 120, pl. 38, fig. 23.

Material: 2 specimens. Their dimensions are 9.6 x 7.0 x 5.4 mm (HO 827) and 9.2 x 6.7 x 6.8 mm (figured, HO 828-GBA 2004/2/5).

Description and remarks. Both specimens have convex valves, strong subrounded ribs and slightly incurved, high ventral beak. They are in accord with detailed Bittner's description of this Carnian species. However, the brachial valves have only 4 ribs on each side of a medium rib. Inconspicuous median groove, which developed according to Bittner (1890) on this medium rib, is ascertainable in our specimens only in anterior part. Shell outline, ribs and pedicle beak differentiate the de-

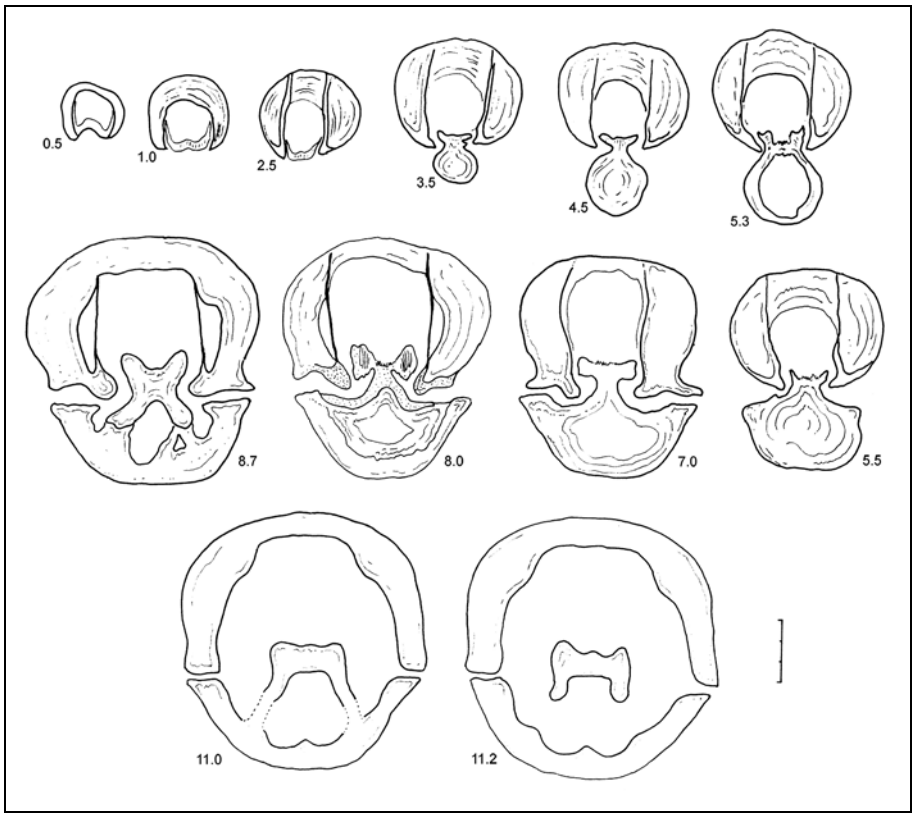


Fig 6 - *Oxycolpella eurycolpos* (Bittner). HO 18. Karlhochkogel. Total length of specimen 32.5 mm. Enlarged, bar equals 3 mm.

scribed species from other retziid brachiopods, which occur in the Cassian Beds. The occurrence of retziid brachiopods in younger deposits than Carnian is less frequent. Basing on the present study, the range of *Hungarispira loretzi* is extended to the Early Norian. The scarcity of suitable material for sectioning precludes the confirmation of the generic affiliation of *H. loretzi*. However, Dagys' attribution to *Hungarispira* (1972, p. 102) seems to be reasonable and is followed here.

Range. Carnian - Early Norian.

Distribution. Karlhochkogel. Carnian of the Southern Alps (Cassian Beds).

Remarks. The specimens correspond well to the detailed description by Bittner (1890). On one hand, due to their subcircular outline they are similar to Bittner's specimen on fig. 18 in plate 29. On the other hand, they differ externally from the Anisian *Schwagerispira schwageri* (Bittner) and from the Norian/Rhaetian *Neoretzia superba* (Suess) in stronger and sharper ribs (8-9 in the brachial valves).

Range. Lower Carnian - Norian.

Distribution. Karlhochkogel. Austria, Slovakia, Romania, ?Hungary.

Subfamily Hustediinae Grunt, 1986

Schwagerispira Dagys, 1972

Schwagerispira fastosa (Bittner, 1890)

Pl. 2, Fig. 2

1890 *Retzia schwageri* m. var. *fastosa* Bittner, p. 274, pl. 29, fig. 17-20.

1958 *Retzia schwageri fastosa* - Mahel', p. 143, pl. 5, fig. 8-10.

1988 *Schwagerispira fastosa* - Siblík, p. 89 (cum syn.).

1994 *Schwagerispira fastosa* - Siblík, p. 369, pl. 1, fig. 9 (cum syn.).

Material: 6 small partly damaged specimens (HO 831-836). The biggest one is figured (HO 833-GBA 2004/2/2) and measures 9.3 x 8.4 x 7.0 mm, the other well-preserved specimens have the dimensions 8.9 x 7.1 x 7.0 mm (HO 834) and 8.5 x 8.0 x 6.9 mm (HO 835).

Suborder **Koninckinidina** Harper, 1993

Superfamily Koninckinoidea Davidson, 1853

Family Koninckinidae Davidson, 1853

Amphiclina Laube, 1866

Amphiclina intermedia Bittner, 1890

Pl. 3, fig. 7

1890 *Amphiclina intermedia* Bittner (incl. var. *praeceps*), p. 271, pl. 30, fig. 26-29, pl. 40, fig. 7-9.

1963 *Amphiclina intermedia* - Dagys, p. 135, pl. 31, fig. 5-9.

1974 *Amphiclina intermedia* - Dagys, text-fig. 29, 43, pl. 26, fig. 4.

1988 *Amphiclina intermedia* - Siblík, p.15 (cum syn.).

Material: 1 specimen with dimensions 11.4 x 11.9 x 6.4 mm (HO 437-GBA 2004/2/18).

Description. Concavo-convex smooth shell of rounded trigonal outline. Lateral parts of shell nearly straight, widely rounded anterolateral margins passing into gently convex anterior margin. Hinge line straight and very narrow. Beak incomplete, with poorly developed beak ridges. Pedicle valve regularly convex in lateral profile, with shallow median depression in its anterior half. Anterior and lateral commissures straight. Very fine radial striae perceptible on surface of valves.

Remarks. Detailed description of the species inclusive of internal structure was given by Dagys (1963). Our specimen shows the close resemblance to the Bittner's specimen depicted in pl. 40, fig. 8. *Amphiclina aptera* Bittner from the Cassian Beds is comparable to *A. intermedia* in its outline and anterior view. It differs from *A. intermedia* in its lateral profile, showing unusual maximum convexity near the anterior margin.

Range. Carnian - Norian. Austria, Romania, Bulgaria, Crimea, Caucasus, ?China.

Distribution. Karlhochkogel.

Amphiclina? sp.

Pl. 3, fig. 9

Material: 1 specimen measuring 10.9 x 10.3 x 4.3 mm (HO 438-GBA 2004/2/20).

Description and remarks. The specimen is characterized by concavo-convex shell of round outline, very short hinge line and damaged suberect (?) beak. Surface of valves is covered by poorly visible faint branching ribs in number about 20, resp. 40 near anterior margin of brachial, resp. pedicle valve. With some hesitation is the specimen here referred to *Amphiclina.*

Distribution. Karlhochkogel.

Order **Spiriferinida** Ivanova, 1972

Suborder **Cyrtinidina** Carter & Johnson, 1994

Superfamily Suessioidea Waagen, 1883

Family Laballidae Dagys, 1962

Subfamily Laballinae Dagys, 1962

Laballa Moisseiev in Dagys, 1962

Laballa suessi (Zugmayer, 1880)

Pl. 3, Fig. 8

1880 *Spiriferina Suessi* Zugmayer, p. 29, pl. 3, fig. 12, 14-19.
1957 *Cyrtina suesssii* - Mahel', p. 168, pl. 5, fig. 11.
1965 *Laballa suessi* - Dagys, text-fig. 42.
1977 *Laballa suessi* - Pearson, p. 21, pl. 2, fig. 3-5, text-fig.2 (cum syn.).
1978a *Laballa suessi* - Iordan, pl. 2, fig. 13, pl. 3, fig. 1.
1988 *Laballa suessi* - Siblík, p. 74, pl. 3, fig. 1 (partim, cum syn.).
1998a *Laballa suessi* - Siblík, p. 82 (cum syn.).
2001 *Laballa suessi* - Siblík, p. 22 (cum syn.).

Material: 24 partially damaged shells, 16 brachial and 8 pedicle valves, and 2 juvenile specimens (HO 387- 436). The specimens reach 33.5 mm in length, 43.0 mm in width and 22.0 mm in thickness. The specimen figured in Pl. 3, fig. 8 (HO 418-GBA 2004/2/19) has the following dimensions: ca. 31 x 39.0 x ca.16 mm.

Description and remarks. Detailed descriptions of both external and internal characters of this species were given by Dagys (1963) and Pearson (1977). Our specimens show nearly straight beak and have longer hinge line. Angularly raised, pronounced strong fold is present in brachial valve and deepened sulcus in pedicle valve. Fold and sulcus are sharply delimited laterally from the remainder of shell. In all mentioned characters our material differs from Dagys' specimens from the Caucasus and shows considerable resemblance to that from the Alpine Kössen Formation. Internal characters of our specimens are identical with those in Pearson's text-fig. 2, and those in fig. 21 in Siblík 1998b from Kitzberg, both from the Kössen Formation.

Range. Norian - Rhaetian.

Distribution. Karlhochkogel. Austria, Slovakia, Hungary, Bulgaria, Romania, Turkey, Crimea, Pamir, Caucasus, China, California. Recently, Sandy (2001) reported on the occurrence in Alaska.

Superfamily Spondylospiroidea Hoover, 1991

Family Spondylospiridae Hoover, 1991

Subfamily Spondylospirinae Hoover, 1991

Zugmayerella Dagys, 1963

Zugmayerella koessenensis (Zugmayer, 1880)

1880 *Spiriferina Kössenensis* Zugmayer, p. 28, pl. 3, fig. 2-3, 5, 13.
1977 *Zugmayerella koessenensis* - Pearson, p. 27, pl. 2, fig. 1-2, text-fig. 6-7 (cum syn.).
1988 *Zugmayerella koessenensis* - Siblík, p. 75, pl. 3, fig. 5 (cum syn.).
1998a *Zugmayerella koessenensis* - Siblík, p. 81, pl. 2, fig. 2 (cum syn.).
2000 *Zugmayerella koessenensis* - Siblík in Turnšek et al., p. 137, pl. 6, fig.6.

Material: 1 brachial and 3 crushed pedicle valves (HO 458-461). The most complete pedicle valve measures approx. 12.0 x 16.0 mm (HO 460).

Description. The brachial valve has medially flattened fold and 6 rounded ribs on lateral slopes. Pyramidal pedicle valve with high, plane cardinal area completely covered with longitudinal denticular ridges. Prominent unribbed sulcus and 6-7 narrow, rounded ribs on the lateral slopes. No recurvation of the beak.

Remarks. Owing to the mentioned external characters, there is no doubt about the identity. The internal characters of this species were studied and figured by Dagys (1963) and Pearson (1977).

Range. Norian - Rhaetian.

Distribution. Karlhochkogel. Austria, Bavaria, Slovakia, Ukrainian Carpathians, Bulgaria, Romania, Crimea, Caucasus.

Suborder **Spiriferinidina** Ivanova, 1972

Superfamily Spiriferinoidea Davidson, 1884

Family Spiriferinidae Davidson, 1884

Subfamily Spiriferininae Davidson, 1884

Mentzelioides Dagys, 1974

Mentzelioides cf. **budensis** (Hofmann, 1873)

Fig. 7

cf. 1873 *Spiriferina budensis* Hofmann, p. 183, pl. 12, fig. 2.

Material: 6 poorly preserved fragments of pedicle valves (HO 462- 467). The complete ones have dimensions 21.0 x 28.1 mm (HO 464) and 16.7 x ?20 mm (HO 466).

Description. Medium-sized smooth valves with width greater than length. Hinge line straight and shorter than maximum width. Lateral margins rounded. Interarea height similar to interarea width. Beak strong, incurved. Very shallow, large sulcus is present in four valves. Two valves have median flattening only. Punctae visible on one valve. Dental lamellae and median septum divided. As seen on external surface, septum reaches anterior half of valve.

Remarks. Our specimens are very similar in dimensions, outline and character of sulcation to *Spiriferina budensis*. However, compared to Hofmann's figures they tend to have more incurved beaks and areas. Remains of shell in 1 specimen revealed an unusual composite perforation, which is a characteristic feature of *Mentzelioides*. According to Dagys (1974, p. 66), small round perforations represent true punctae, while greater elongate perforations are prolongations of spine channels from secondary layer of shell (Fig. 7).

Range. *Spiriferina budensis* Hofmann was found in the Norian Hauptdolomit in Hungary and established on 1 pedicle valve only.

Distribution. Karlhochkogel.

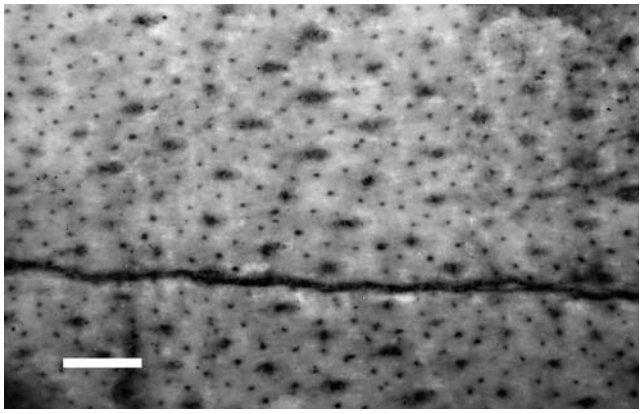


Fig 7 - *Mentzelioides* cf. *budensis* (Hofmann). HO 466. Karlhochkogel. Pedicle valve showing small true punctae and larger channel terminations (according to Dagys 1974). Bar equals 0.5 mm.

Subfamily Mentzeliinae Dagys, 1974

Mentzelia Quenstedt, 1870

Mentzelia sp.

Fig. 8

Material: 11 fragments of poorly preserved pedicle valves (HO 679-689). The dimensions of the best preserved specimens are 32.0 x 35.0 x ?39 mm (HO 680) and ?24 x ?26 x 30.0 mm (HO 685).

Description. Large smooth valves with short and straight hinge line. Relatively low, incurved beak. Very shallow, not sharply delimited sulcation. Serial sections revealed dental plates uniting posteriorly with each other, fusing with strong club-like septum and forming a short spondylium. Both sectioned valves showed septum continuing into spondylial cavity.

Remark. Specific assignment of the specimens is made impossible owing to the insufficient details.

Distribution. Karlhochkogel.

Family Sinucostidae Xu & Liu, 1983

Subfamily Sinucostinae Xu & Liu, 1983

Sinucosta Dagys, 1963

Sinucosta emmrichi (Suess, 1854)

Figs 9-10, Pl. 3, figs 1, 4, ?5

1854 *Spirifer emmrichi* Suess, p. 52, pl. 2, fig. 7.

1963 *Sinucosta emmrichi* - Dagys, p. 105, text-fig. 47, pl. 13, fig. 8-11.

1977 *Sinucosta emmrichi* - Pearson, p. 16, text-fig. 1, pl. 1, fig. 8-14 (cum syn.).

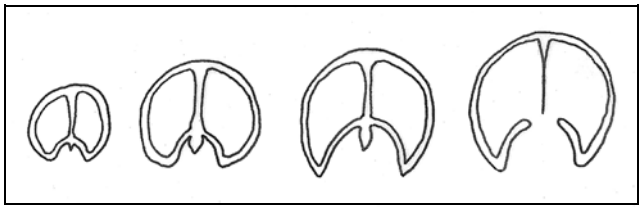


Fig 8 - *Mentzelia* sp. HO 683. Karlhochkogel. Four transverse sections through the posterior part of pedicle valve, showing short spondylium. Original length of specimen 13.5 mm. Magnified.

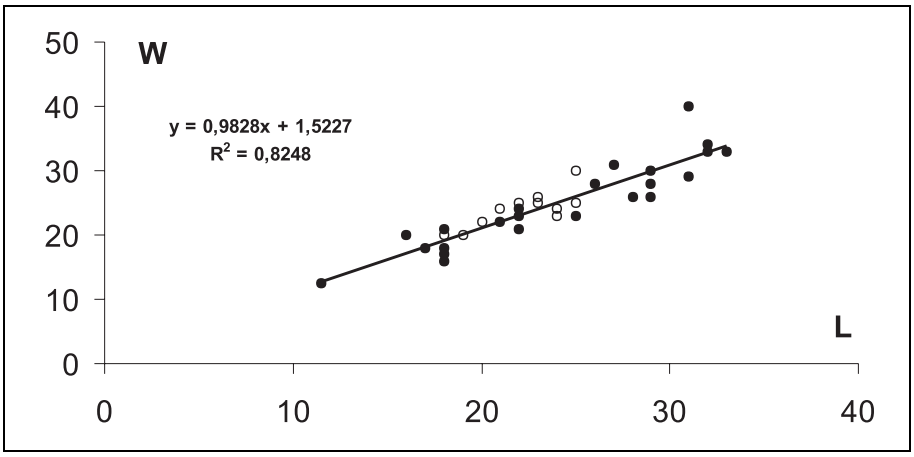


Fig 9 - *Sinucosta emmrichi* (Suess). Karlhochkogel. Width-length scattergram (in mm) for 45 well-preserved pedicle valves of *Sinucosta emmrichi* (Suess). White circle = 2 specimens.

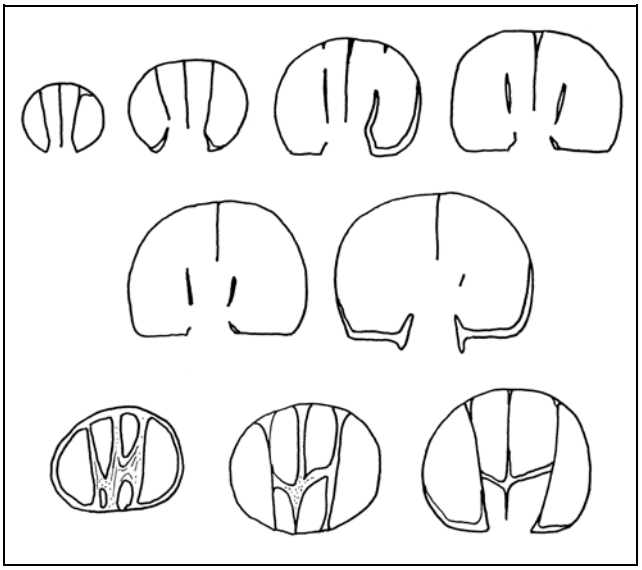


Fig 10 - *Sinucosta emmrichi* (Suess). Karlhochkogel. Incomplete transverse sections through the posterior part of pedicle valve. Above: HO 792, original length 19.0 mm. Bottom: Another specimen (HO 750, length ca. 22.5 mm), showing short connections between dental lamellae. All enlarged.

1988 *Sinucosta emmrichi* - Siblík, p. 68, pl. 1, fig. 5 (cum syn.).
2001 *Sinucosta emmrichi* - Siblík, p. 21 (cum syn.).

Material: 4 shells, 8 brachial and 135 pedicle valves, with length up to 33.0 mm and width up to 34.4 mm (HO 679-825). The figured specimens measure ?46 x 41.3 mm (HO 731-GBA 2004/2/12, Pl. 3, fig. 1) and ?33 x ?39 mm (HO 790- GBA 2004/2/15, Pl. 3, fig.4). The best-preserved specimen with both valves (HO 690) has dimensions 10.5 x 12.3 x ?10 mm. Moreover, 2 small (possibly juveniles) differently ribbed specimens with both valves are also assigned to this species as ?*Sinucosta emmrichi* juv. (HO 837-838). One of these (HO 838- GBA 2004/2/ 16) is figured in Pl. 3, fig. 5; it measures 11.8 x 10.3 x 7.8 mm.

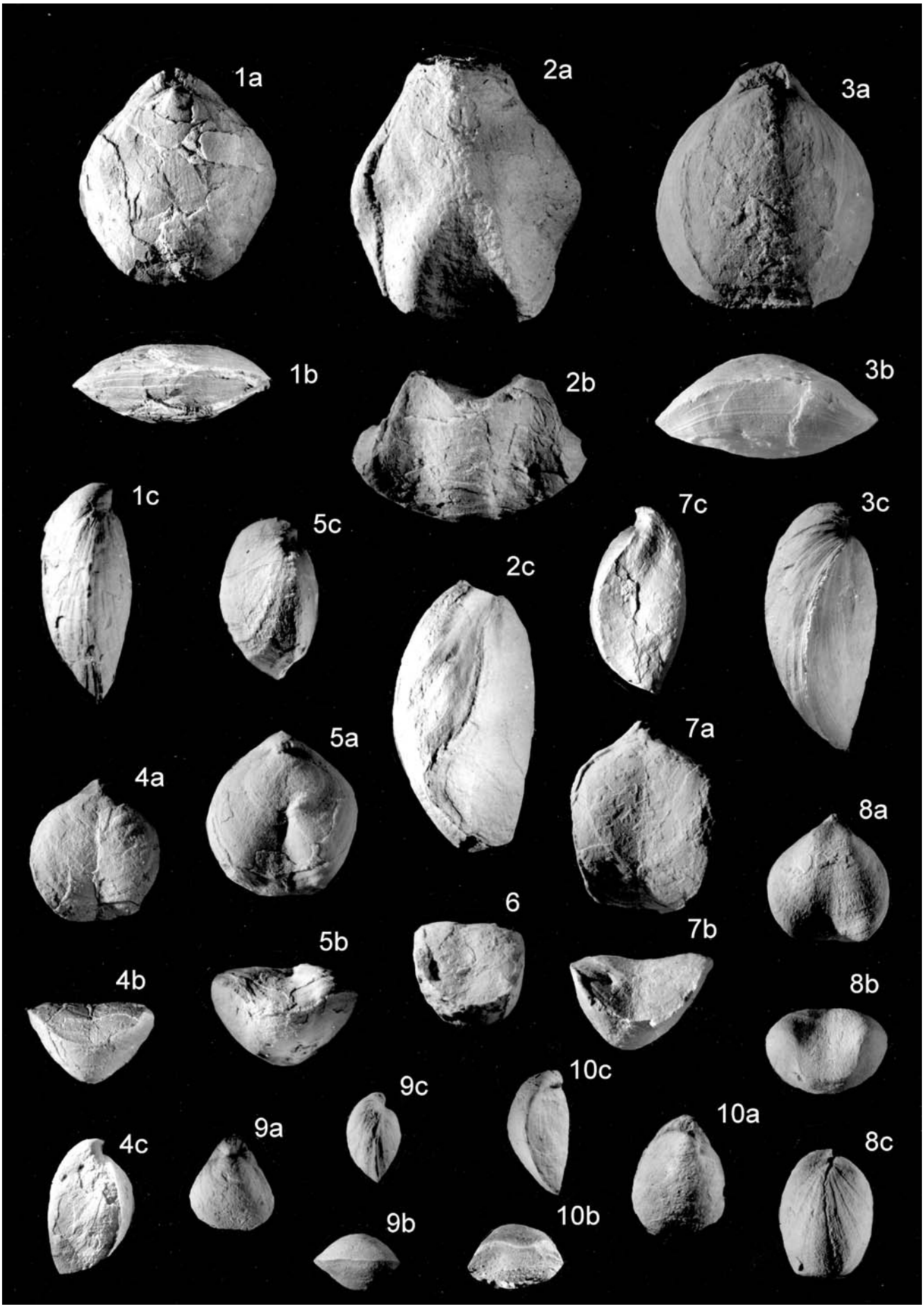
Description. Brachial and pedicle valves anteriorly and laterally rounded. Hinge line straight in small specimens. Pedicle valve with high, clearly delimited apsacline area (up to procline one in small specimens) and only slightly recurved beak. Very faint striation visible on area of some better preserved valves. Indistinct fold in brachial valve, and very shallow sulcus or more frequently medial flattening present in pedicle valve. Dense ornamentation made by 40-60 fine ribs in average. Some pedicle valves with up to 75 somewhat sinuous ribs. Common branching of ribs visible in anterior third of valves. Only incomplete sections could be made and these show essential features of the species given by Dagys (1963) and Pearson (1977). Dental lamellae divided from ventral septum are longer than those shown by Dagys.

Remarks. Detailed descriptions were given by Zugmayer (1880) and later by Dagys (1963) and Pearson (1977) who described internal characters. All three authors also pointed out a large variability of ribbing. According to me, Pearson's incorporation of *Sinucosta multicostata* Dagys, *Sinucosta bittneri* Dagys (both in Dagys 1963) and *Guseriplia acerrima* (Bittner) in Siblík 1967 (= *Spiriferina emmrichii* var. *acerrima* Bittner, 1890) into synonymy of *S. emmrichi* is thus substantiated. The majority of our material can be distinguished from *S. emmrichi* coming from Kössen Formation and from "*Spiriferina emmrichii* var. *subtilicostata*" Bittner, 1890. This is because our specimens show only slightly recurved ventral beak with apsacline area, imperceptible

PLATE 4

All specimens are from Karlhochkogel.

Fig. 1 - *Zeilleria austriaca* (Zugmayer). GBA 2004/2/21, x 1.5.
Fig. 2 - *Adygella biplicata* Dagys. GBA 2004/2/22, x 1.5.
Fig. 3 - *Rhaetina pyriformis* (Suess). GBA 2004/2/23, x 2.
Fig. 4 - *Aulacothyris* ex gr. *reflexa* (Bittner). GBA 2004/2/24, x 2.
Fig. 5 - *Aulacothyris* aff. *telleri* Bittner. GBA 2004/2/25, x 3.
Fig. 6 - *Aulacothyris* ex gr. *reflexa* (Bittner). GBA 2004/2/26, x 2.
Fig. 7 - *Aulacothyris* ex gr. *reflexa* (Bittner). GBA 2004/2/27, x 2.
Fig. 8 - *Norella guttula* (Bittner). GBA 2004/2/28, x 3.
Fig. 9 - "*Terebratula*" sp.; juv. (?). GBA 2004/2/29, x 3.
Fig. 10 - ? "*Terebratula* " *sturi juvavica* Bittner. GBA 2004/2/30, x 3.


1a
2a
3a
1b
2b
3b
1c
5c
7c
3c
2c
5a
7a
4a
8a
6
5b
7b
4b
8b
9c
10c
10a
9a
4c
8c
9b
10b

fold and sulcus and very dense ornamentation. Based on these differences, it might be possible that the specimens from Hochschwab represent a distinct subspecies or even species. However, because of the high morphologic variation, the Hochschwab material is incorporated in *S. emmrichi*. For the present, it seems that there is no real justification for splitting. With some hesitation, 2 other (juvenile?) specimens (HO 837-838) are also assigned to the species under consideration. They could be distinguished from the majority due to their recurved ventral beak with anacline area, short hinge line, shallow sulcation and stronger ribbing. The only resemblance to these specimens could be found in "*Spiriferina* spec. indet." figured by Bittner (1890) in plate 40, fig. 36 and coming from the Wettersteinkalk (?).

Range. Norian - Rhaetian, common in the Kössen Formation.

Distribution. Karlhochkogel. Austria, Bavaria, Slovakia, Romania, Bulgaria (also Carnian?), Crimea, Caucasus, Iran, Pamir, China.

Sinucosta cf. **bittneri** (Dagys, 1963)

cf.1963 *Guseriplia bittneri* Dagys, p. 109, pl. 14, fig. 10-12.

Material: 2 incomplete pedicle valves (HO 468-469). The better preserved one (HO 469) measures approx. 13 x 11 mm.

Description. Moderately convex, ribbed valve with incurved beak. Clearly delimited cardinal area smooth, inornate. Sulcus distinct and extending to the umbo, with 2 ribs. Lateral slopes of sulcus with 5 strong and rounded ribs.

Remarks. The similarity in the mentioned external characters enables to compare the specimens to *Sinucosta bittneri* Dagys. Pearson (1977) studied the large variability of ribbing within *Guseriplia* Dagys (= *Sinucosta*) and considered *S. bittneri* and another new species *Guseriplia multicostata* Dagys, 1963 to be synonymous. He included them into *Sinucosta emmrichi* (Suess, 1854), the type species of *Sinucosta*. According to him, the coarse morphotype of *G. multicostata* cannot be separated from *S. bittneri,* both belonging to the *S. emmrichi* plexus. Similarly "*Spiriferina emmrichi* var. *acerrima*", which was described by Bittner (1890) from the Norian of Drnava in the West Carpathians, and put into synonymy of *Guseriplia bittneri* by Dagys (1963, p. 109), was embodied by Pearson (1977) in *Sinucosta emmrichi*.

Range. *Sinucosta bittneri* was described from the Norian - Rhaetian of the Caucasus (Dagys, 1963).

Distribution. Karlhochkogel.

Order **Terebratulida** Waagen, 1883

Suborder **Terebratulidina** Waagen, 1883

Superfamily Dielasmatoidea Schuchert, 1913

Family Dielasmatidae Schuchert, 1913

Subfamily Dielasmatinae Schuchert, 1913

Adygella Dagys, 1959

Adygella biplicata Dagys, 1963

Fig. 11, Pl. 4, fig. 2

1963 *Adygella biplicata* Dagys, p. 169, pl. 26, fig. 5-6.

Material: 22 partially damaged shells and 7 pedicle valves (HO 470-498). The largest specimen (HO 481-GBA 2004/2/22, figured) measures ca. 35 x 29.4 x 17.8 mm. Complete sectioned specimens measured 28.2 x 21.1 x 10.2 mm (HO 474, Fig. 11), 26.5 x 20.0 x 13.0 mm (HO 475) and 24.3 x 18.0 x 9.5 mm (HO 489).

Diagnosis. Large subpentagonal shells, longer than wide. Two strong costae on brachial valve. Anterior commissure bisulcate. Beak erect. Short dental lamellae, septalial plates forming large septalium.

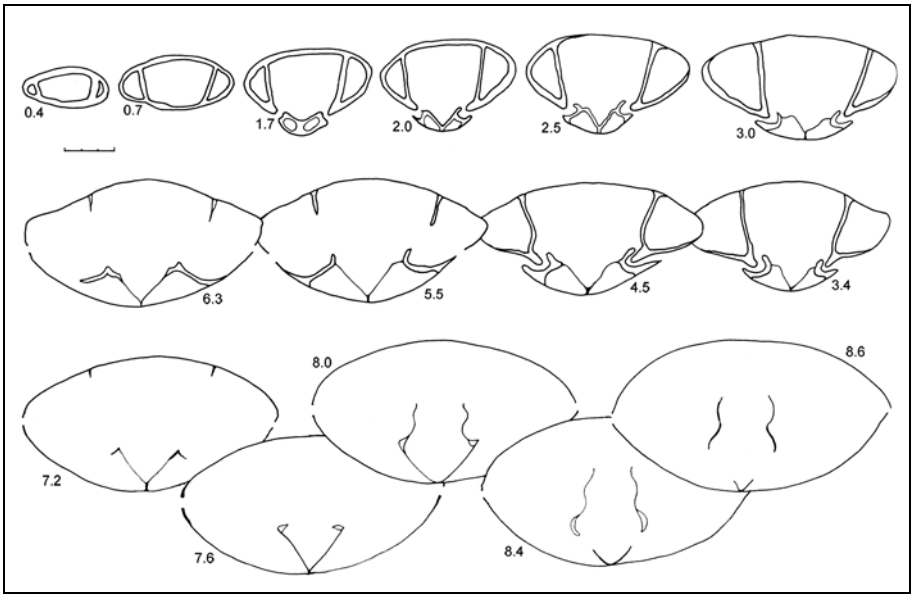


Fig 11 - *Adygella biplicata* Dagys. HO 474. Karlhochkogel. Total length of specimen 28.2 mm. Enlarged, bar equals 3 mm. One of six ground specimens showed a well-developed pedicle collar.

Description. 29 large shells of subpentagonal outline, biconvex in profile, reaching 35.0 mm in length, 30.0 mm in width and 18.5 mm in thickness. The maximum width is situated in the mid-length. Moreover, 2 smaller specimens of subtrigonal outline with an equal length and width. Anterior commissure bisulcate (episulcate). The prominent beak is erect, with rounded beak ridges. Two costae are developed on the brachial valve. They are strong in the figured specimen, where large and high biplication is developed in anterior half of valve. They are weak in other specimens with slight biplication observable near the anterior margin of shell. Both valves are smooth posteriorly. Ventrally diverging dental lamellae delimiting large delthyrial cavity, relatively thin hinge teeth freely in broad sockets, hinge plates clearly demarcated from both inner socket ridges and septalial plates, deep septalium supported by a very low median septum, septalial plates anteriorly attached to the floor of brachial valve, high-arched crural processes, transverse band not observed.

Remarks. The variable intensity of the biplication is visible also in the material figured by Dagys (1963). The considerable external resemblances to our specimens could be also found in *Adygella bittneri* (Wöhrmann, 1889) [= *Terebratula woehrmanniana* Bittner, 1890] from the Alpine Carnian deposits. This species is, however, much smaller and has rounded outline and sulciplicate anterior margin. The type species *Adygella cubanica* Dagys, 1959 differs in having a rectimarginate anterior margin and longer dental lamellae.

Range. According to Dagys (1963) Norian - Rhaetian.

Distribution. Karlhochkogel. The species was described from the NW Caucasus and SE Pamir. The present find in Hochschwab is the only known occurrence outside the type area.

Rhaetina Waagen, 1882

Rhaetina pyriformis (Suess, 1854)

Fig. 12, Pl. 4, fig. 3.

1854 *Terebratula pyriformis* Suess, p. 41, pl. 3, fig. 6-7.
1975 *Rhaetina pyriformis* - Michalík, p. 62, pl. 3, 2-5, pl. 4, fig. 6-7, text-fig. 13-20.
1977 *Rhaetina pyriformis* - Pearson, p. 39, pl. 5, fig. 1-7, text-fig. 12 (cum syn.).
1988 *Rhaetina pyriformis* - Siblík, p. 99 (cum syn.).
1998a *Rhaetina pyriformis* - Siblík, p. 83, pl. 3, fig. 2-3, text-fig. 13-15 (cum syn.).
2001 *Rhaetina pyriformis* - Siblík, p. 30 (cum syn.).

Material: 25 mostly incomplete shells and 3 pedicle valves, up to 39.0 mm long, 29.5 mm wide and 17.5 mm thick (HO 649-676). The dimensions of the figured specimen (HO 668-GBA 2004/2/23) are 23.0 x 20.5 x 10.6 mm. Sectioned specimens measured 33.5 x 26.2 x 13.5 mm (HO 650, Fig. 12) and ?26 x 23.4 x 11.3 mm (HO 661).

Description. The species was described in detail by Dagys (1963), Michalík (1975) and Pearson (1977). Transversal sections showed oblique hinge plates uniting over a low septum and broad septalium. Short and narrow outer hinge plates -if recognized- subhorizontal, joining inner socket ridges. Transversally flattened transverse band. Due to the poor preservation of posterior parts of all 4 sectioned specimens, the development of cardinal process could not be confirmed.

Remarks. The species is common in the Alpine Kössen Formation and shows considerable external and internal variability. Our figured specimen is very similar in wider subcircular outline to the specimen from Kaisersteffel, Lower Austria figured by Zugmayer (1880) in pl. 1, fig. 17. Characteristic broadly plicate anterior commissure is in some our specimens substituted by a nearly rectimarginate anterior margin, and a very strong beak by a less prominent one. De-

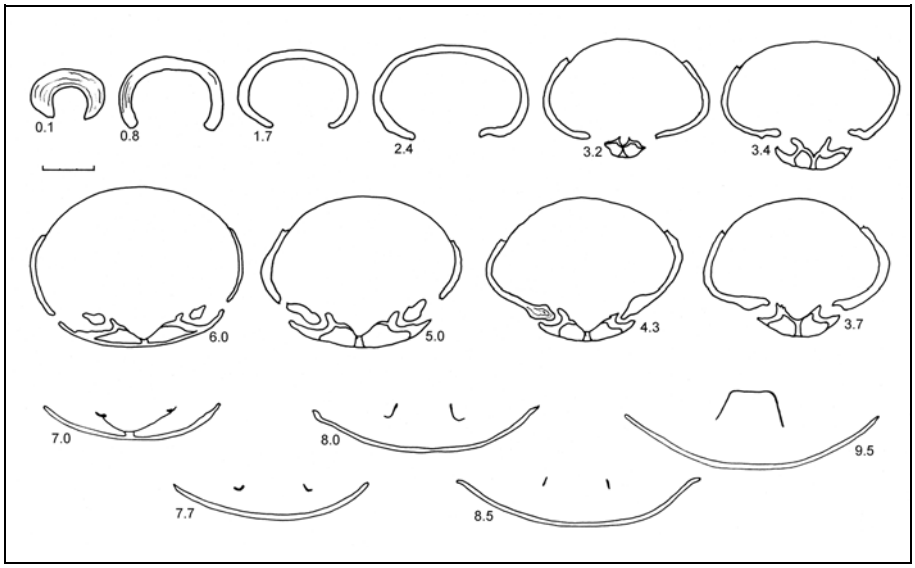


Fig 12 - *Rhaetina pyriformis* (Suess). HO 650. Karlhochkogel. Length of specimen 33.5 mm. Enlarged, bar equals 3 mm.

velopment of septalium and median septum ascertained in our sectioned specimens has not been known in *Rhaetina* material from the Kössen Formation, where inner hinge plates characteristically extend to the floor of brachial valve. However, the septalium was found and figured by Dagys (1963) in *Rhaetina pyriformis* (fig. 64) and *Rhaetina gregaria* (fig. 63) coming from the Norian - Rhaetian limestones of NW Caucasus. It can be supposed that this represents the intraspecific variability.

Range. Norian - Rhaetian.

Distribution. Karlhochkogel. Austria, Bavaria, Switzerland, Slovakia, Poland, Ukrainian Carpathians, Hungary, Romania, Italy, Iran, Crimea, Caucasus, California.

Rhaetina sp.

Material: 40 mostly fragmentary and/or damaged specimens up to ?37 mm long, ?35 mm wide and ?18 mm thick (HO 609-648). Only 3 specimens appear to be complete and these are too damaged for specific determination.

Description. Medium- to large terebratulids with elongate to subcircular outline and equally convex. Valves very flat in lateral profile. Smooth valves without fold or sulcus, with some growth lines discernible. Most specimens characterized by sharpened margins of shell, straight lateral commissure and rectimarginate anterior commissure only exceptionally with slight uniplication. Beak – if preserved – low and of erect attitude, with subrounded beak ridges. Serial sections have been taken through 12 better preserved fragments. These show the typical internal features of *Rhaetina*: oblique inner hinge plates fused with floor of valve, and absent dental lamellae.

Remarks. Studied specimens show considerable variation in terms of shell outline and lateral profile. *Rhaetina* sp. can be distinguished from *R. pyriformis* mainly by subcircular outline and thin, sharpened lateral profile.

Distribution. Karlhochkogel.

Superfamily Terebratuloidea Gray, 1840

Family Terebratulidae Gray, 1840

Subfamily Terebratulinae Gray, 1840

Terebratula Müller, 1779; s.l.

? "Terebratula" sturi juvavica Bittner, 1890

Pl. 4, fig. 10

1890 *Terebratula sturi* Laube var. Bittner, p. 257, pl. 28, fig. 1 (on the plate named as *Terebratula sturi* Laube var. *juvavica* n.).

Material: 1 specimen (HO 841-GBA 2004/2/30) has dimensions 8.0 x 6.2 x 4.0 mm.

Description. Ovate biconvex shell with maximum width situated anteriorly of mid-length. Brachial valve longitudinally vaulted, with strongly inclined flanks and depressed posterolateral parts. Its thickness is more than twice greater in lateral view than that of pedicle valve. Anterior commissure with faint sulciplication. Lateral commissure strongly arched towards ventral valve. Ventral beak strong and large, with long protruding beak ridges. Foramen incomplete.

Remarks. Our specimen is preliminarily compared to "*Terebratula" sturi juvavica*, which was based by Bittner on 1 existing specimen only. Bittner's specimen has similarly vaulted brachial valve and characteristically arched lateral commissure. However, our specimen has much smaller dimensions and rounded outline (juvenile?).

Distribution. Karlhochkogel. Bittner's holotype of "*Terebratula" sturi juvavica* originated from the Norian "Salzburger Hochgebirgskorallenkalk", locality

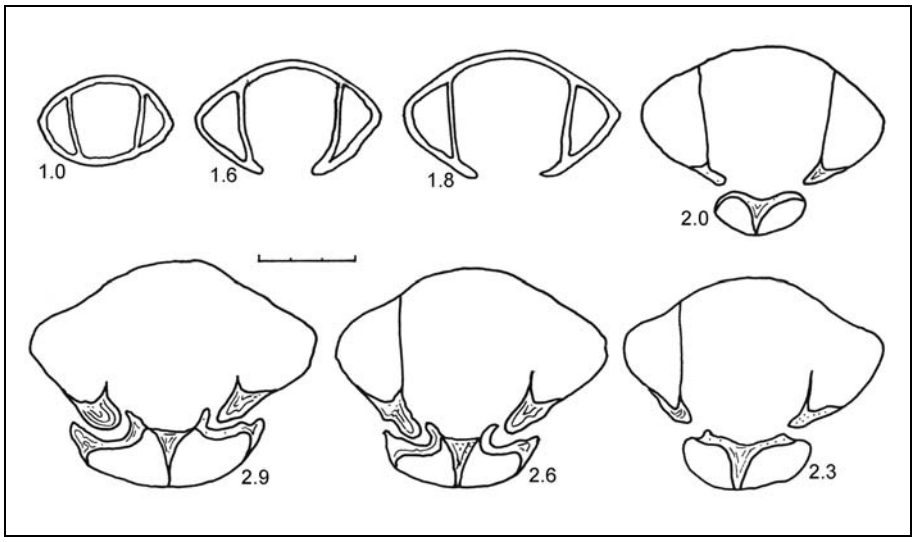


Fig 13 - *Zeilleria austriaca* (Zugmayer). HO 452. Karlhochkogel. Original length 21.5 mm. Due to the bad preservation, only 7 transverse sections through the posterior part of the specimen could be made. Enlarged, bar equals 3 mm.

Putzenköpfl in Hallein – Dürrnberg. The species was reported also from Bulgaria.

"Terebratula" sp., juv. (?)

Pl. 4, fig. 9

Material: 1 specimen with the dimensions 5.8 x 5.0 x 3.6 mm (HO 842 - GBA 2004/2/29).

Description. Minute, smooth equi-biconvex shell of subtrigonal outline without any fold or sulcus, anterior commissure plane, erect beak strong with obscure beak ridges, punctate.

Remark. With regard to the small size of the specimen and to missing data about its interior, it is impossible to say more of its taxonomic appurtenance.

Distribution. Karlhochkogel.

Lobothyris Buckman, 1918

Lobothyris cf. **praepunctata** (Bittner, 1890)

cf. 1890 *Terebratula praepunctata* Bittner, p. 257, pl. 28, fig. 2-5.

Material: 8 incomplete shells, reaching ?23 mm in length, ca. 18 mm in width and 13.0 mm in thickness (HO 440-447).

Description. Medium-sized, equibiconvex smooth shells of ovate to subcircular outline. Lateral and anterior commissures straight. Neither fold nor sulcus developed. Medium width situated forward of the mid-length. Relatively strong beak with rounded beak ridges, erect in attitude. Faint concentric growth lines perceptible anteriorly in some specimens. Dental lamellae and dorsal septum absent, hinge plates subhorizontal.

Remarks. Some of our specimens could be compared to the specimens figured by Bittner (1890) on pl. 28, fig. 2 and 5 but their maximum width is situated more anteriorly and thus the shell outline is slightly different. Internal features are typical of *Lobothyris*.

Range. *Lobothyris praepunctata* was described by Bittner from the light-coloured Dachsteinkalk (Norian) found in the Lechnergraben near Mariazell, Styria.

Distribution. Karlhochkogel.

Suborder **Terebratellidina** Muir-Wood, 1955

Superfamily Zeillerioidea Allan, 1940

Family Zeilleriidae Allan, 1940

Aulacothyris Douvillé, 1879

Aulacothyris aff. **telleri** Bittner, 1892

Pl. 4, fig. 5

aff. 1892 *Waldheimia (Aulacothyris) telleri* Bittner, p. 18, pl. 3, fig.31.

Material: 1 specimen measuring 10.4 x 9.2 x 6.0 mm (HO 439-GBA 2004/2/25).

Description. Ventribiconvex smooth shell, subcircular in outline. Pedicle valve slightly more convex toward beak than forwards, brachial valve of much lesser convexity. Deep, well-delimited sulcus developed in the anterior half of brachial valve. Lateral commissures straight. Anterior commissure with a shallow subangular sinus in its middle part. Beak rather massive, low and incurved. Beak ridges subrounded. Few concentric lines observed on brachial valve. Externally, short dental lamellae with length about one-fifth of the total length of pedicle valve are visible. Dorsal septum visible in the posterior half of valve.

Remarks. Our specimen is well comparable by its outline, by remarkable difference in convexity between valves and by character of beak to *Aulacothyris telleri* Bittner. However, it differs from this species in deeper, subangular sinuation of anterior margin and in stronger development of posterior parts of pedicle valve. Some external resemblances could be found in some other upper Triassic terebratulid species. Our specimen differs from *Aulacothyris conspicua* Bittner (1890, pl. 26, fig.6), *Aulacothyris rupicola* Bittner (1892, pl. 3, fig. 33) and *Camerothyris dualis* Bittner (1890, pl. 5, fig. 12 – var. *globularis*) by its deeper sulcus of brachial valve and deeper sinuation of anterior commissure. Moreover, it has a straight lateral commissure. *Aulacothyris patricia* Bittner (1890, pl. 26, fig. 20) can be distinguished from our specimen by sharper anterior view, by weaker development of sulcus in anterior half of brachial valve resulting in shallow sinus of anterior commissure, and by shorter dorsal septum.

Range. *Aulacothyris telleri* was described by Bittner from the Carnian (?) limestone found in Oberseeland (= Zgornje Jezersko, Slovenia).

Distribution. Karlhochkogel.

Gemerithyris Siblík, 1977

Gemerithyris aff. **zugmayeri** (Bittner, 1891)

Pl. 3, fig. 6

aff. 1891 *Waldheimia (Aulacothyris) zugmayeri* Bittner, p. 55, 57.
aff. 1994 *Gemerithyris zugmayeri* - Siblík, p. 374, pl. 3, fig. 11.

Material: 1 specimen with dimensions 19.0 x 15.9 x 10.2 mm (HO 678-GBA 2004/2/17).

Description and remarks. Plano-convex shell with intraplicate anterior commissure, sulcate brachial

valve with short median fold, and long dorsal septum reaching anterior margin of shell are characters reminding Bittner's species *Aulacothyris zugmayeri*. However, this species differs from our specimen in smaller size, narrow subpentagonal outline, blunt median rib and long, well-developed sulcation in pedicle valve.

Range. *Aulacothyris zugmayeri* was described by Bittner (1891) from the„Korallenkalke der Raxalpe", Lower Austria. The age of the limestones was reported by Diener in his catalogue (1920, p. 103) as Norian. Lein and Siblík (1978, p. 213) supposed that the age of the brachiopod-bearing localities on Raxalpe is Cordevolian -? Julian.

Distribution. Karlhochkogel.

Zeilleria Bayle, 1878

Zeilleria austriaca (Zugmayer, 1880)

Fig. 13, Pl. 3, fig. 2, Pl. 4, fig. 1

1880 *Waldheimia austriaca* Zugmayer, p. 17, pl. 2, fig. 12-14.
1958 *Waldheimia (Zeilleria) austriaca* - Mahel', p. 150.
1977 *Zeilleria austriaca* - Michalík, p. 336, text-fig. 7.3.
1978c *Zeilleria austriaca* - Iordan, p. 72, pl. 4, fig. 4.
1998a *Zeilleria austriaca* - Siblík, p. 84, pl. 3, fig. 6, text-fig. 16 (cum syn.).
2001 *Zeilleria austriaca* - Siblík, p. 34 (cum syn.).

Material: 9 partly incomplete specimens (HO 449-457). The figured specimens measure 28.0 x 24.8 x 11.2 mm (HO 450-GBA 2004/2/21, Pl. 4, fig.1) and 25.2 x 23.8 x 9.4 mm (HO 454-GBA 2004/2/13, Pl. 3, fig. 2). The sectioned specimen measured 21.5 x 7.4 mm (HO 452).

Description and remarks. The species was described in detail by Zugmayer (1880) and Michalík (1977). Faint capillation on the valves ascertained by Zugmayer (1880) could be traced in the brachial valve of our specimen figured in Pl. 3, fig. 2. Short dental lamellae, hinge plates clearly delimited from the inner socket ridges, strong teeth with deep sockets and very shallow septalium are the main characters. The same features were ascertained by Siblík (1998) in the specimen of *Z. austriaca* from Steinplatte. Due to poor preservation, the length of dorsal septum and character of loop could not be studied in the Hochschwab material.

Range. Norian - Rhaetian.

Distribution. Karlhochkogel. Austria, Switzerland, Slovakia, Poland, Bulgaria, Romania, Crimea.

Family Aulacothyropsididae Dagys, 1972

Aulacothyropsis Dagys, 1959

Aulacothyropsis ex gr. **reflexa** (Bittner, 1890)

Fig. 14, Pl. 4, figs 4, 6-7

ex gr. 1890 *Waldheimia (Aulacothyris) reflexa* Bittner, p. 258, pl. 26, fig. 21.

Material: 110 partially damaged shells up to 23.0 mm long, 17.5 mm wide and 16.0 mm thick (HO 499-608). The figured specimens measure: 14.0 x 12.0 x 7.8 mm (HO 460-GBA 2004/2/24, Pl. 4, fig. 4), 16.2 x 11.0 x 10.8 mm (HO 461-GBA 2004/2/26, Pl. 4, Fig. 6) and 17.5 x 13.2 x 8.8 mm (HO 485-GBA 2004/2/27, Pl. 4, fig. 7). The sectioned specimen (HO 538) measured 18.5 x 14.6 x 10.8 mm.

Description. Concavo-convex or plano-convex elongate terebratulids of medium to large size. Outline subpentagonal to rounded, with maximum width situated in the posterior half of shell. In dorsal view, lateral sides of most specimens subparallel or anteriorly converging, anterior margin round or straight and passing into anterolateral parts under 90 – 110 °. Brachial valve with large but shallow sulcation reaching up to umbo. Lateral commisures strongly sinuate. In lateral view, pedicle valve hiding nearly totally the brachial one. Anterior commissure with broad sinus of variable depth. Beak prominent, relatively narrow and erect.

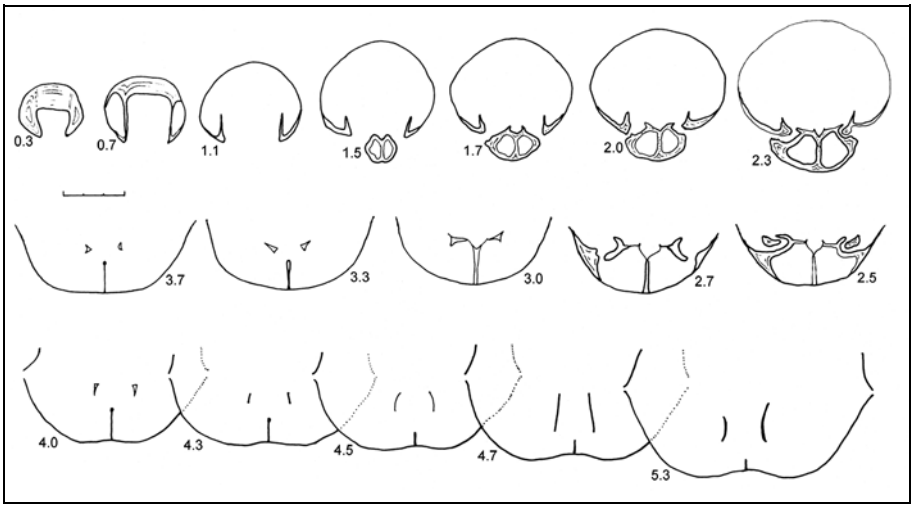


Fig 14 - *Aulacothyropsis* ex gr. *reflexa* (Bittner). HO 538. Karlhochkogel. Original length of specimen 18.5 mm. Transverse sections showed very short dental lamellae. Long dorsal septum remains as a low ridge nearly up to the anterior margin of valve. Enlarged, bar equals 3 mm.

Beak ridges subrounded. Apical angle 80 – 110°. Pedicle collar not ascertained, subparallel dental lamellae short but traced to section 2.3 (Fig. 14), lateral delthyrial cavities narrow, hinge plates subhorizontal and well delimited from both septalial plates and inner socket ridges, relatively narrow septalium supported by high dorsal septum, septum very long, reaching anterior margin of the valve, crural processes ventrally inclined, transverse band not observed.

Remarks. Specimens are highly variable in external characters, mainly in outline and anterior view. There are few Upper Triassic terebratulids described from the Northern Alps having very deep anterior sinuation as shown in Pl. 4, fig. 6 and 7b. Certain similarity in this respect can be found in *Aulacothyris reflexa*, which was based on one specimen only and described by Bittner in 1890. Its variability is thus unknown. Most of our specimens differ from it in their elongate outline with subparallel sides. Three specimens are well comparable to Bittner's specimen due to their subtrigonal outline with maximum width in posterior half of shell and by slightly concave antero-lateral parts of shell in dorsal view. However, they differ from *A. reflexa* by broader sinuation and slightly convex brachial valve in anterior view. In respect to the subpentagonal specimen with abnormally deep and broad sinuation as shown in Pl. 4, fig. 6, the only parallel in Upper Triassic could be found in narrow specimens of *Gemerithyris copiosa* Siblík, 1990 from the Tuvalian of the Slovak Karst. However, this species can be distinguished from *A. reflexa* mainly by the maximum width situated near the anterior margin.

Range. The only one Bittner's specimen of "*Waldheimia (Aulacothyris) reflexa*" originated from the Norian "Hochgebirgskorallenkalk" (= reef facies of the Dachstein Limestone) of the Tristlwand in the Hagengebirge Mts., Salzburg. It is deposited in the collection of the Geologische Bundesanstalt in Vienna (no.1890/2/340).

Distribution. Karlhochkogel.

Conclusions

The knowledge of brachiopods from the reef Dachstein Limestone was very limited in the Northern Calcareous Alps. The occurrence of a very rich and variable brachiopod fauna of 28 species from the Hochschwab area described in this paper is thus surprising and important. It is dominated by *Aulacothyropsis* ex gr. *reflexa* (Bittn.), *Sinucosta emmrichi* (Suess) and *Oxycolpella eurycolpos* (Bittn.). All this indicates that brachiopods were common inhabitants of reef habitats during the Norian. Seven species occur also in the younger, Rhaetian deposits of the Northern Calcareous Alps (Kössen Formation). On one hand, some of the determined species as *Laballa suessi* (Zugm.), *Zugmayerella koessenensis* (Zugm.), *Schwagerispira fastosa* (Bittn.) and *Zeilleria austriaca* (Zugm.) are well comparable to the same taxa from the Kössen Formation. On the other hand, several other species differ in some external and internal morphologic features from their average Kössen namesakes. For example, *Fissirhynchia fissicostata* has an upright beak, a well-developed septalium and a high dorsal septum in some specimens. *Rhaetina pyriformis* has a less prominent beak with subrounded beak ridges and differently developed septalium and septum, and *Sinucosta emmrichi* has a much finer ribbing. These variations in internal and external morphology are supposed to represent the intraspecific variability of these species. There might be both stratigraphical and environmental significance in these variations. In contrast to their abundance in the Hochschwab, *Sinucosta* and *Aulacothyropsis* are mostly rare in the Rhaetian deposits of the Nothern Calcareous Alps. *Oxycolpella oxycolpos*, as the relative of *O. eurycolpos* can be very abundant locally in the Upper Rhaetian deposits of the Northern Calcareous Alps. Two species, *Adygella biplicata* (Dagys) and Ladinian *Hungaritheca loretzi* (Bittner), were documented as new inhabitants in the Alpine Norian. The accompanying macrofauna consisted of poorly preserved, indeterminable bivalves. The conodonts found at Karlhochkogel Mt. belong to *Epigondolella triangularis* (Budurov 1972) confirming the Early Norian (Lacian 2) age of the brachiopod-bearing reef limestones.

Acknowledgments. We are particularly grateful to G.W. Mandl and H. Priewalder for their kind assistance in preparing the conodont plate, and to L. Krystyn for the determination of the conodont fauna. M. Siblík is grateful to O. Kreuss for information about the occurrence of brachiopods in vicinity of the Fölzalm. The brachiopod study (within the framework of the IGCP projects 458 and 467) was made possible thanks to financial support by the Grant Agency of the Academy of Sciences of the Czech Republic to M. S. (project A 3013801, 1998-2000) for most of the samplings, which have been done in the Hochschwab area, and by the Grant Agency of the Czech Republic for the present project 205/03/1123 to finish the study. Financial help for field works in 1999 and 2000 to M. S. by the Austrian Academy of Sciences is heartily acknowledged.

REFERENCES

Ager D. V., Gutnic M., Juteau Th. & Monod O. (1978) - New Early Mesozoic brachiopods from southern Turkey. *Bull. Miner. Res. Explor. Inst. Turkey*, 91: 59-75, Ankara.

Bittner A. (1884) - Aus den Salzburger Kalkhochgebirgen. Zur Stellung der Hallstätter Kalke. *Verh. K. K. Geol. Reichsanst.*: 99-113, Wien.

Bittner A. (1890) - Brachiopoden der alpinen Trias. *Abh. K. K. Geol. Reichsanst.*, 14: 1-320, Wien.

Bittner A. (1891) - Triasbrachiopoden von der Raxalpe und vom Wildangergebirge bei Hall in Tirol. *Verh. K. K. Geol. Reichsanst.*: 55-60, Wien.

Bittner A. (1892) - Brachiopoden der alpinen Trias. Nachtrag I. *Abh. K. K. Geol. Reichsanst.*, 17: 1-38, Wien.

Bronn H. G. (1832) - Die Versteinerungen des Salza-Thales, in Beziehung auf Lill von Lilienbach's Beschreibung dortiger Gebirgs-Formationen. *Jb. Miner. Geogn. Geol. Petref.*, 3: 150-182, Heidelberg.

Bryda G., Kreuss O., Mandl G. W., Moser M., Pavlik W., Decker K. et al. (2002) - Erstellung moderner geologischer Karten als Grundlage für karsthydrogeologische Spezialuntersuchungen im Hochschwabgebiet. *Endbericht für den Projektabschnitt 1. Juni 2000 - 31. Mai 2002*, Geologische Bundesanstalt, 211 pp., Wien.

Dagys A. S. (1963) - Upper Triassic brachiopods of the Southern USSR. V. of 238 pp. Acad. Publ. House, Moscow (in Russ.).

Dagys A. S. (1965) - Triassic brachiopods of Siberia. 186 pp. Publ. House "Nauka", Moscow (in Russ.).

Dagys A. S. (1972) - Morphology and systematics of the Mesozoic retzioid brachiopods. *Transact. Inst. Geol. Geoph. Acad. Sci.*, 112: 94-105, Novosibirsk (in Russ.).

Dagys A. S. (1974) - Triassic brachiopods (morphology, classification, phylogeny, stratigraphical significance and biogeography). *Transact. Inst. Geol. Geoph. Acad. Sci.*, 214: 1-322. Nauka, Novosibirsk (in Russ.).

Davidson Th. (1856) - Classification der Brachiopoden. 160 pp., Wien (transferred to German by Suess E.).

Diener K. (1920) - Brachiopoda triadica. *Fossilium Catalogus I, Animalia*, 10: 108 pp., Berlin.

Flügel E. (1981) - Paleoecology and facies of Upper Triassic reefs in the Northern Calcareous Alps. *SEPM Special Publication,* 30: 291-359, Tulsa, Oklahoma.

Hofmann K. (1873) - Beiträge zur Kenntniss der Fauna des Hauptdolomites und der älteren Tertiär-Gebilde des Ofen - Kovácsier Gebirges. *Mitt. aus J. Kön. Ung. Geol. Anst.*, 2: 181-206, Pest.

Iordan M. (1978a) - The Triassic brachiopods from the Rarău syncline and the Perşani Mountains areas. *Dări de seamă ale şedinţ.*, 64 (3. *Paleont.*): 69-84, Bucureşti.

Iordan M. (1978b) - Notă asupra brachiopodelor Triasic - Superioare de la Gura Sadovei. *Anal. Univ. Bucur. Geol.*, 27: 47-56, Bucureşti.

Iordan M. (1978c) in Bordea J., Iordan M., Tomescu C. & Bordea S. - Contributii biostratigrafice asupra Triasicului superior din unitatea di Ferice (Munţii Bihor). *Dări de seamă şedinţ.*, 64 (4. *Stratigr.*): 63-78, Bucureşti.

Iordan M. (1993) - Triassic brachiopods of Romania. In: Pálfy J. & Vörös A. (eds.) - Mesozoic Brachiopods of Alpine Europe. Hung. Geol. Soc.: 49-58, Budapest.

Kristan-Tollmann E. & Tollmann A. (1962) - Die Mürzalpendecke - eine neue hochalpine Großeinheit der östlichen Kalkalpen. *Sitzber. Österr. Akad. Wiss. (math.-nat. Kl.),* Abt. *I,* 171: 7-39, Wien.

Lein R. & Siblík M. (1978) - A brachiopod fauna from the Spielkogel (Muerztaler Alpen, Styria): New data concerning the stratigraphic emplacement of *Tetractinella* (?) *dyactis* (Bittner). *Mitt. Ges. Geol. Bergbaustud.*, 25: 205-221, Wien.

Lobitzer H. (1971) - Fazielle Untersuchungen an triadischen Karbonatplattform/Becken Gesteinen des südöstlichen Hochschwabgebietes (Wetterstein- und Reiflingerkalk, Dachstein- und Aflenzer Kalk. *Dissertation*, Phil. Fak. Univ. Wien, 206 p., Wien.

Lobitzer H. (1975) - Fazielle Untersuchungen an norischen Karbonatplattform -Beckengesteinen (Dachsteinkalk - Aflenzer Kalk im südöstlichen Hochschwabgebiet, Nördliche Kalkalpen, Steiermark). *Mitt. Geol. Ges. Wien*, 66 (1973): 75-91, Wien.

Mahel' M. (1957) - Geológia Stratenskej hornatiny. *Geol. Práce*, 48a: 1-199, Bratislava (in Slovak).

Mahel' M. (1958) - Geologie des Gebirges Stratenská hornatina. *Geol. Práce*, 48b: 1- 201, Bratislava (German version of Mahel' M., 1957).

Mantovani N. (2002) - The genus *Tetractinella* Bittner, 1890: morphology, ultrastructure, and 3D reconstruction. *Riv. It. Paleont. Strat.*, 108: 37-50, Milano.

Michalík J. (1975) - Genus *Rhaetina* Waagen, 1882 (Brachiopoda) in the uppermost Triassic of the West Carpathians. *Geol. Zborník*, 26: 47-76, Bratislava.

Michalík J. (1977) - Systematics and ecology of *Zeilleria* Bayle and other brachiopods in the uppermost Triassic of the West Carpathians. *Geol. Zborník*, 28: 323-346, Bratislava.

Pearson D. A. B. (1977) - Rhaetian Brachiopods of Europe. *N. Denkschr. Naturhist. Mus. Wien,* 1: 1-70, Wien.

Ratschbacher L., Frisch W., Linzer H.G. & Merle O. (1991) - Lateral extrusion in the Eastern Alps, Part II. Structural analysis. *Tectonics*, 10: 257-272, American Geophysical Union, Washington D.C.

Sandy M. R. (2001) - Mesozoic articulated brachiopods from the Western Cordillera of North America: their significance for palaeogeographic and tectonic reconstruction, palaeobiogeography and palaeoecology. In: Brachiopods Past and Present. *System. Assoc. Spec. Vol. Ser.* 63: 394-410, London and New York.

Siblík M. (1967) - The brachiopods of the Norian locality Drnava (Southern Slovakia). *Geol. Práce, Zprávy*, 43: 81-97, Bratislava (in Czech).

Siblík M. (1988) - Brachiopoda triadica. *Catalogus Foss. Austriae*, Vc 2 (a): 1-131, Wien.

Siblík M. (1990) - Carnian terebratulid brachiopods from the Slovak Karst (SE Slovakia). *Knih. Zem. Plynu Nafty*, 9b: 109-145, Hodonín.

Siblík M. (1994) - The brachiopod fauna of the Wetterstein Limestone of the Raxalpe (Austria). *Jb. Geol. B.- A.*, 137: 365-381, Wien.

Siblík M. (1998a) - A Contribution to the Brachiopod Fauna of the "Oberrhätkalk" (Northern Calcareous Alps, Tyrol - Salzburg). *Jb. Geol. B.-A.*, 141: 73-95, Wien.

Siblík M. (1998b) - Carnian spire-bearing brachiopods from the Slovak Karst (SE Slovakia). *Slovak Geol. Mag.*, 4: 121-136, Bratislava.

Siblík M. in Turnšek D., Dolenec T., Siblík M., Ogorelec B., Ebli O. & Lobitzer H. (1999) - Contribution to the Fauna (Corals, Brachiopoda) and Stable Isotopes of the Late Triassic Steinplatte Reef/Basin Complex, Northern Calcareous Alps, Austria. *Abh. Geol. B.-A.*, 56/2: 121-140, Wien.

Siblík M. (2001) - Brachiopoda triadica - Supplementum. *Catalogus Foss. Austriae*, Vc 2 (a): 1-45, Wien.

Spengler E. (1920) - Zur Stratigraphie und Tektonik der Hochschwabgruppe. *Verh. Geol. Staatsanst.*: 49-60, Wien.

Stur D. (1871) - Geologie der Steiermark. 654 pp., Graz.

Suess E. (1854) - Über die Brachiopoden der Kössener Schichten. *Denkschr. K. Akad. Wis.* (*math.- naturwiss. Kl.*), *Abt. 2*, 7: 29-64, Wien.

Tollmann A. (1964) - Zur Frage der Faziesdecken in den Nördlichen Kalkalpen etc. *Geol. Rundsch.*, 53: 151-168, Stuttgart.

Zugmayer H. (1880) - Untersuchungen über rhätische Brachiopoden. *Beitr. Paläont. Geol. Öster.-Ung.*, 1: 1-42, Wien.