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BIVALVES AND BRACHIOPODS NEAR THE PERMIAN-TRIASSIC BOUNDARY FROM THE BÜKK MOUNTAINS (BÁLVÁNY-NORTH SECTION, NORTHERN HUNGARY)

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Abstract. In the Bükk Mountains the Upper Permian is represented by the Nagyvisnyó Limestone, which contains very rich marine assemblages. It is overlain by the Gerennavár Limestone (uppermost Permian–Lower Triassic) which records the effects of the Permian–Triassic mass extinction with a dramatic decrease in diversity and abundance of fossils. The basal Gerennavár Limestone is represented by a clayey marl unit (basal beds) deposited in a quiet, low-energy marine environment below the storm wave-base, whose maximum thickness, about one meter, is recorded in the Bálvány-North section. From this locality a relatively diversified and abundant marine benthonic assemblage has been collected, and is here described. Bivalves are represented by: *Bakevellia* cf. *ceratophaga* (Schlotheim),? Pterinopectinidae gen. et sp. indet., *Eumorphotis lorigae* sp. n., the most abundant species, *Entolium piriformis* (Liu) and *Pernopecten latangulatus* Yin. Brachiopods are less frequent, and the following four species have been identified: *Spinomarginifera* sp., *Orthothetina ladina* (Stache), *Ombonia tirolensis* (Stache) and *Orbicoelia tschernyschewi* (Likharew). An exact age of this fauna, based on conodonts, is not yet available, but the strong affinities with those of the lower Tesero Member (Dolomites) and the Lower Kathwai Member (Pakistan) suggest a latest Permian age (? *praeparvus* Zone). If so, the Bálvány-North section becomes one of the few in the world which records the last bioevents of the Palaeozoic.

Riassunto. Nei Monti Bükk dell'Ungheria settentrionale il Permiano superiore è rappresentato dalla Nagyvisnyó Limestone che contiene ricche associazioni di ambiente marino. Segue la Gerennavár Limestone (Permiano finale - Triassico inferiore) che registra gli effetti catastrofici della estinzione di massa permo-triassica con un drammatico calo di diversità ed abbondanza dei fossili. La base della Gerennavár Limestone è rappresentata da una unità di marne argillose (Basal beds), depositatesi in un ambiente marino calmo al di sotto della base di tempesta; questa unità raggiunge il massimo spessore, di circa un metro, nella sezione di Bálvány-North. Da questa località proviene una associazione bentonica marina discretamente diversificata ed abbondante che viene descritta per la prima volta nel presente lavoro.

I bivalvi sono rappresentati da: *Bakevellia* cf. *ceratophaga* (Schlotheim),? Pterinopectinidae gen. et sp. indet., *Eumorphotis lorigae* sp. n. (specie dominante), *Entolium piriformis* (Liu) e *Pernopecten latangulatus* Yin. I brachiopodi sono meno frequenti; essi sono rappresentati dalle seguenti quattro specie: *Spinomarginifera* sp., *Orthothetina ladina* (Stache), *Ombonia tirolensis* (Stache) e *Orbicoelia tschernyschewi* (Likharew). Non è ancora possibile stabilire con precisione, sulla base dei conodonti, l'età della fauna. Tuttavia la forte affinità con le faune della parte basale del Membro di Tesero (Dolomiti) e del Lower Kathwai Member (Pakistan) suggeriscono un Permiano finale (? *praeparvus* Zone). In tal caso, la sezione di Bálvány-North diviene una delle poche al mondo che registra gli ultimi bioeventi del Paleozoico.

Introduction

The Permian/Triassic (P/Tr) mass extinction is considered to be the most severe extinction of the Phanerozoic (e.g. Erwin 1993). Unfortunately, only few areas in the world (e.g. South China, Kashmir, Salt Range, Greenland, Dolomites) record the bio-events that occurred during the latest Permian and earliest Triassic interval. The Bükk Mountains (Northern Hungary) may represent one of these due to the discovery, here described, of a relatively rich bivalve and brachiopod assemblage near the P/Tr boundary.

The Upper Permian succession of the Bükk Mountains is represented by the Nagyvisnyó Limestone deposited in the photic zone of a shallow subtidal ramp. This unit contains very rich, diversified flora and fauna assemblages (Fülöp 1994; Haas et al. 2004). The overlying Gerennavár Limestone (uppermost Permian–Lower Triassic) begins with a thin basal shaley unit which contains a relatively rich bivalve and

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brachiopod assemblage, described in this paper. It is followed by a few meter-thick laminated limestone which grades upward into thick-bedded poorly fossiliferous limestone. In the Bükk Mountains there are several sections where the boundary between the formations is exposed, but the richest bivalve and brachiopod assemblage has been discovered only in the Bálvány-North section (Csontos-Kiss & Pelikán 1990), in which the maximum thickness (about 1 m) of the basal shaley beds of the Gerennavár Limestone occurs. The aim of this paper is to determine and describe the bivalve and brachiopod fauna from this section and to discuss its chronological setting. The recent approval of the GSSP of the P/Tr boundary in the Meishan section at the first appearance of the conodont *Hindeodus parvus* Kozur & Pjatakova (Yin 2000; Orchard 2001) has concluded the uncertainty and the long controversy on the position of erathem boundary. This made it possible to determine objectively the age of the bioevents located near the P/Tr boundary in conodont-bearing successions and to improve the stratigraphic correlation among them.

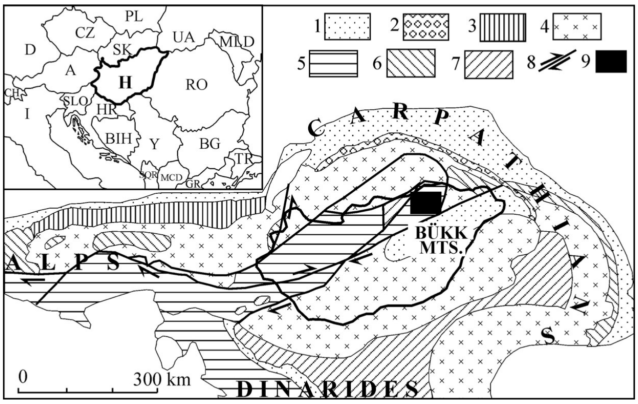


Fig. 1 - Schematic terrane map of Circum Pannonian Region (Kovács et al. 2000); 1) Flysch Belt, 2) Klippen Belt, 3) Northern Calcareous Alps, 4) Early Alpine unit related to European continental margin, 5) Early Alpine shelf sequences related to the Apulian (Southern Alps and Outer Dinarides) continental margin, 6) Ophiolites of the Penninic Ocean, 7) Ophiolites of the Vardar Ocean, 8) Major strike-slip zones, 9) Bükk Mountains.

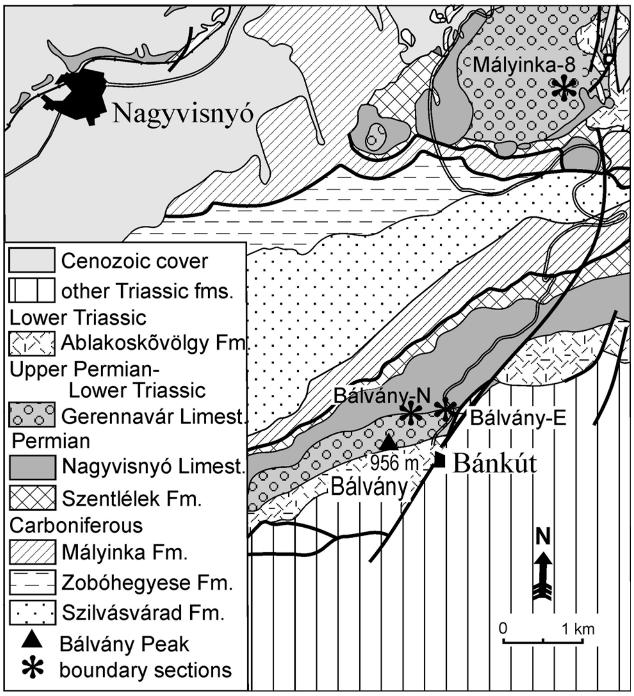


Fig. 2 - Geological sketch map of the northern part of Bükk Mountains (after Less et al. 2002, mod.).

Geological setting

The Bükk Mountains are located in Northern Hungary, south of the Inner Western Carpathians (Fig. 1). Paleozoic–Mesozoic succession of the Bükk Mountains deposited in the northwestern neighbourhood of the Inner Dinarides, according to several paleogeographic reconstructions (Protić et al. 2000; Filipović et al. 2003). The Bükkia Terrane approached its present-day position during the Tertiary as a result of northeastward dextral strike-slip movements in the zone of the Mid-Hungarian Lineament (summary in Fodor & Csontos 1998).

The Bükk Mountains consist of anchi-metamorphosed Paleozoic–Mesozoic formations that were subjected to intense deformation, and are overlain by non-metamorphic Paleogene–Neogene formations (Árkai 1973, 1983; Csontos 1999). Paleozoic and Lower Triassic formations, and consequently the Permian–Triassic boundary sections, are known only in the area of the northern anticline (Fig. 2) (details in Less et al. 2002).

The Upper Permian and Lower Triassic succession of the Bükk Mountains

The Upper Permian and Lower Triassic formations of the Bükk Mountains (Fig. 3) and their paleontological content were described in detail by Balogh (1964). From 1979 onward, in the framework of the National Key-section Project and mapping program of the Hungarian Geological Institute, Balogh (1981) and Pelikán (1995) have presented a detailed lithological subdivision for the boundary-interval. Fülöp (1994) summarized lithological and biostratigraphical data of the boundary sections, and paleontological studies on foraminifers (Bérczi-Makk 1987; Bérczi-Makk et al. 1995), ostracods and conodonts (Kozur 1985, 1988, 1989), molluscs and brachiopods (Csontos-Kiss & Pelikán 1990) have begun.

The Upper Permian is characterized by the Nagyvisnyó Limestone (250-280 m), a unit equivalent to the Badiota facies of the Bellerophon Formation in the eastern Southern Alps and Dinarides (Žažar beds) (Pešić et al. 1986). It consists of black and dark gray, thick-bedded limestones with thin-bedded marly interlayers, and dolostones at the lower part (Balogh 1964; Fülöp 1994). The Nagyvisnyó Limestone contains rich microflora and micro- and macrofauna consisting of dasycladacean algae, porifers, anthozoans, bivalves, gastropods, nautiloids, ostracods, trilobites, brachiopods, bryozoans, echinoderms, scolecodonts, conodonts, and chondrichthyes (Balogh 1964; Schréter 1963, 1974; Kozur & Mock 1977; Kozur 1985). In the Gerennavár section, the topmost beds of the formation are rich in microfossils (*Gymnocodium*, *Permocalculus*, *Vermiporella*, *Hemigordius*, *Globivalvulina*, *Paraglobivalvulina*, *Pachyphloia*, *Climacammina*, *Agathammina*, Nodosaridae, Fusulinaceae) (Pešić et al. 1986). From this section, *Dagmarita altilis* Wang and *Paraglobivalvulina gracilis* Zaninetti et Altiner are also reported (Kozur in Fülöp 1994). According to Kozur (1988, 1989), the formation has an age ranging from Capitanian to early Changhsingian.

The overlying Gerennavár Limestone is 110-140 m thick, and late Changhsingian–Early Triassic in age (Kozur 1988). The lowermost part of the Gerennavár Limestone (9,5 m in thickness) is markedly different from the bulk of the formation. It can be subdivided in two units: the basal and the transitional beds.

The basal beds consists of dark gray mica-rich, clayey marls with clayey limestone lenses at the middle part, and calcareous sandstones in one level at the upper part. In the Bálvány-North section the thickness is about 1 m, while in the Gerennavár section the basal beds are strongly reduced tectonically and thus only 4 cm-thick claymarlstone and 4 cm-thick sandstones have been preserved. The characteristic of this interval, compared to the underlying and overlaying lithological

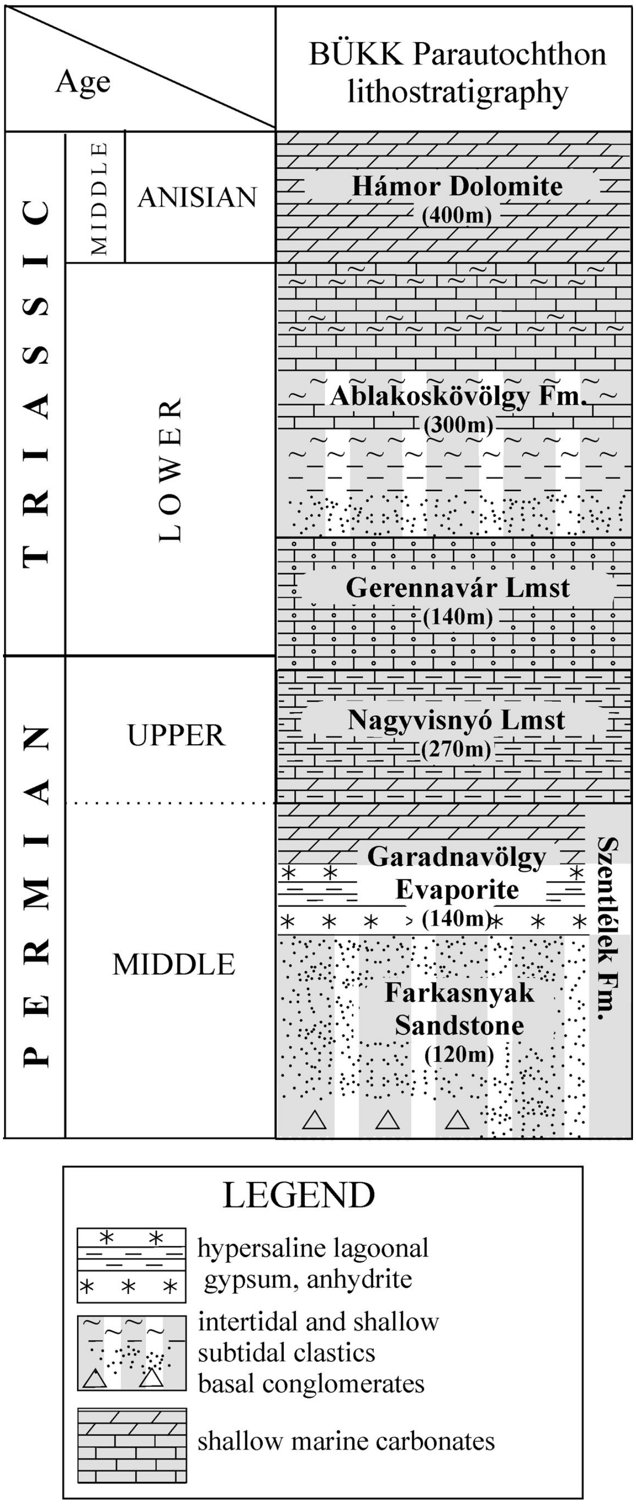


Fig. 3 - Schematic lithostratigraphical division of the Middle Permian–Lower Triassic succession of Bükk Mountains (after Haas 2001, mod.).

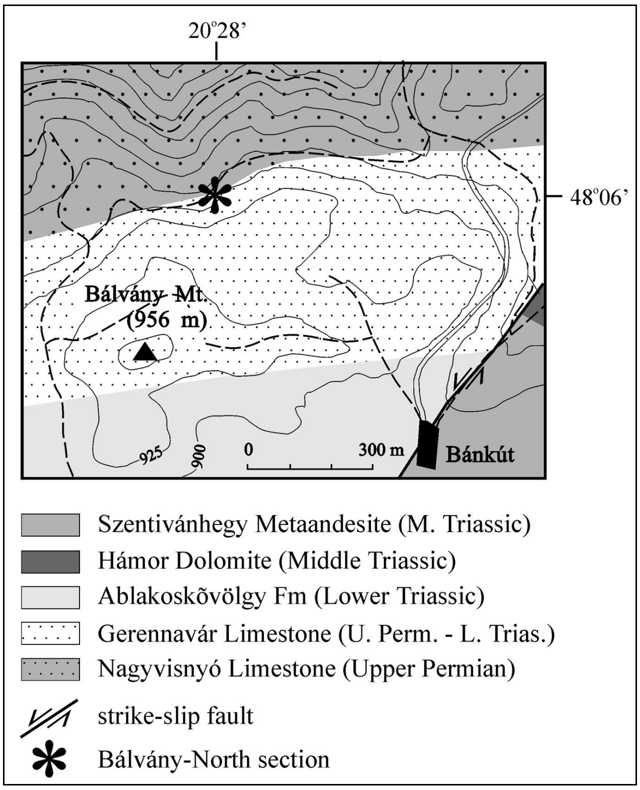


Fig. 4 - Location of the Bálvány-North section (asterisk).

units, is its richness in clay. The deposition took place in a calm, low-energy environment below the storm wave-base.

The transitional beds (about 8,5 m in thickness) are composed of dark grey thin-bedded limestones characterized by fine even lamination in the lower part, and fine crinkle lamination in the upper part. In the succession there is no evidence of subaerial exposure. The laminated limestones were probably deposited in a shallow subtidal environment. Gradation in the planar lamina indicates deposition from waning-flow, or storm currents. The thick crinkle-laminated mudstones in the upper part can be interpreted as a microbial mat formed in the subtidal zone. In the Mályinka-8 well (Fig. 2), the lower 4 m-thick laminated limestone interval contains foraminifers, predominantly *Earlandia tintinniformis* (Mišik), *E. dunningtoni* (Elliott), *E. deformis* Bérczi-Makk, and subordinately *Neotuberitina reitlingerae* (Mikl. Maklay), *Globivalvulina graeca* Reichel, *Geinitzina* sp., *Ammodiscus* sp., *Pachyphloia* sp. (Bérczi-Makk 1987). From the same well, Kozur (1989) reported the ostracod *Indivisia buekkensis* Kozur and the holothuroid *Theelia dzhulfaensis* Mostler et Rahimi-Yazd. In the same interval of Gerennavár section (Bükk Mountains, not included in Fig. 2), the ostracod *Judahella bogshi* Kozur and the conodont *Ellisonia transita* Kozur et Mostler were also found (det. Kozur in Fülöp 1994).

Upwards in the formation, thin- or thick-bedded mudstones 17.5 m in thickness occur. Above these, a gradual increase in the thickness of grainstone interlayers is followed by the appearance of oolitic limestones, which characterized the bulk of the Gerennavár Limestone (Hips & Pelikán 2002).

In the layers overlying the transitional beds, the ostracods *Hollinella tingi* (Patte) and *Langdaia* sp. were described (det. Kozur in Fülöp 1994). In the Mályinka-8 well, an advanced form of *Hindeodus parvus* (Kozur & Pjatakova) appears about 14 m above the formational boundary, whereas it occurs with *Isarcicella isarcica* (Huckriede) and *Ellisonia aequabilis* Staesche at about 70 m from the base of formation (Kozur pers. comm.). In the upper part of the formation *Claraia aurita* (Hauer) and *C.* cf. *aurita* bivalves (Balogh 1964) were encountered constraining the Induan age of this interval.

Bálvány-North section

This section exposes the topmost layers of the Nagyvisnyó Limestone and a complete succession of the basal beds, and the lower part of transitional beds of the Gerennavár Limestone. It is located on the northern side of Bálvány Peak along a forest road (Fig. 2, 4). The road, directed about E-W, exposes the lithostratigraphical boundary several times. The two best exposures are found at a distance of 100 m and 650 m, respectively, from the motorway (Bálvány-East and Bálvány-North sections, Fig. 2, 4); the latter was studied in detail (asterisk in Fig. 4).

At the lower part of the section, thick-bedded black bituminous, bioclastic limestones are exposed for about 80 cm in thickness. Thin-bedded dark gray wackestones, rarely packstones with fine sand- to silt-sized biodetritus, and with thin-bedded marlstones, calcareous marlstones represent the upper beds of the Nagyvisnyó Limestone, 60 cm in thickness (Fig. 5, 6).

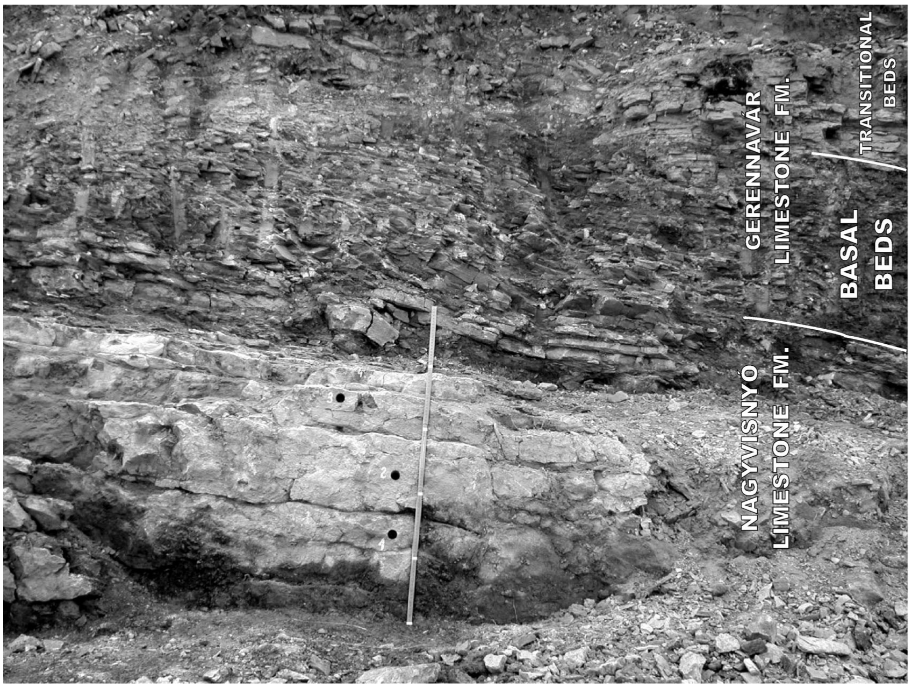


Fig. 5 - The Bálvány-North outcrop (one meter for scale).

The uppermost two, thin mudstone, layers (10 cm) record a dramatic decrease in biogenic component. The bioclasts (2-3%) are mainly represented by the foraminifer *Hemigordius*, fragments of echinoderms, ostracods and brachiopods.

The lithological change from massive limestones to thin-bedded limestones alternating with marlstones, that occur 70 cm below the top of the Nagyvisnyó Limestone, preludes the lithological change at the base of the overlying Gerennavár Limestone. The basal beds of the Gerennavár Limestone consist of 97 cm-thick dark grey (yellowish brown in weathered state), platy, massive, mica-rich claymarls. The bivalve and brachiopod association described in the present paper was collected from these beds (Fig. 5, 6). There is a 2 cm-thick clayey limestone intercalation in its middle part, and 4 cm-thick, brownish gray, fine-grained sandstones at the uppermost part. The sandstones exhibit even lamination due to concentration of mica flakes parallel to the bedding. The basal beds are overlain by the evenly laminated layers of the transitional unit with a sharp lithologic boundary. *Earlandia* sp. and *Gymnocodium* sp. were found in this part of the section (Csontos-Kiss & Pelikán 1990).

In the eastern section, thin- to thick-bedded evenly laminated limestones are overlain by a couple of metre-thick microbial laminated limestones. In the upper part of the exposed section, laminated and massive mudstones alternate.

Molluscs and Brachiopods

The basal beds contain a relatively rich benthic assemblage dominated mainly by epifaunal bivalves and subordinately by small sized brachiopods and very few gastropods. In order to detect the vertical distribution of the taxa, the unit has been divided into 9 subunits, each about 10 cm thick (Fig. 6). The bivalves are dominated by ribbed and spinous pectinoids (*Eumorphotis lorigae* sp. n.); smooth pectinids [*Entolium piriformis* (Liu, 1976) and *Pernopecten latangulatus* Yin, 1982] and bakevelliids [*Bakevellia* cf. *ceratophaga* (Schlotheim, 1816)] have also been found. Brachiopods are less frequent and represented by productids (*Spinomarginifera* sp.), meekellids [*Orthothetina ladina* (Stache, 1878) and *Ombonia tirolensis* (Stache, 1878)] and ambocoeliids [*Orbicoelia tschernyschewi* (Likharew, 1939)]. As concerning the brachiopods, only *Orbicoelia tschernyschewi* and *Spinomarginifera intermediahelica* (Abich, 1878) are present in the underlying Nagyvisnyó Limestone (Schréter 1963). The specimens are mostly deformed due to marly lithotypes, but the bra-

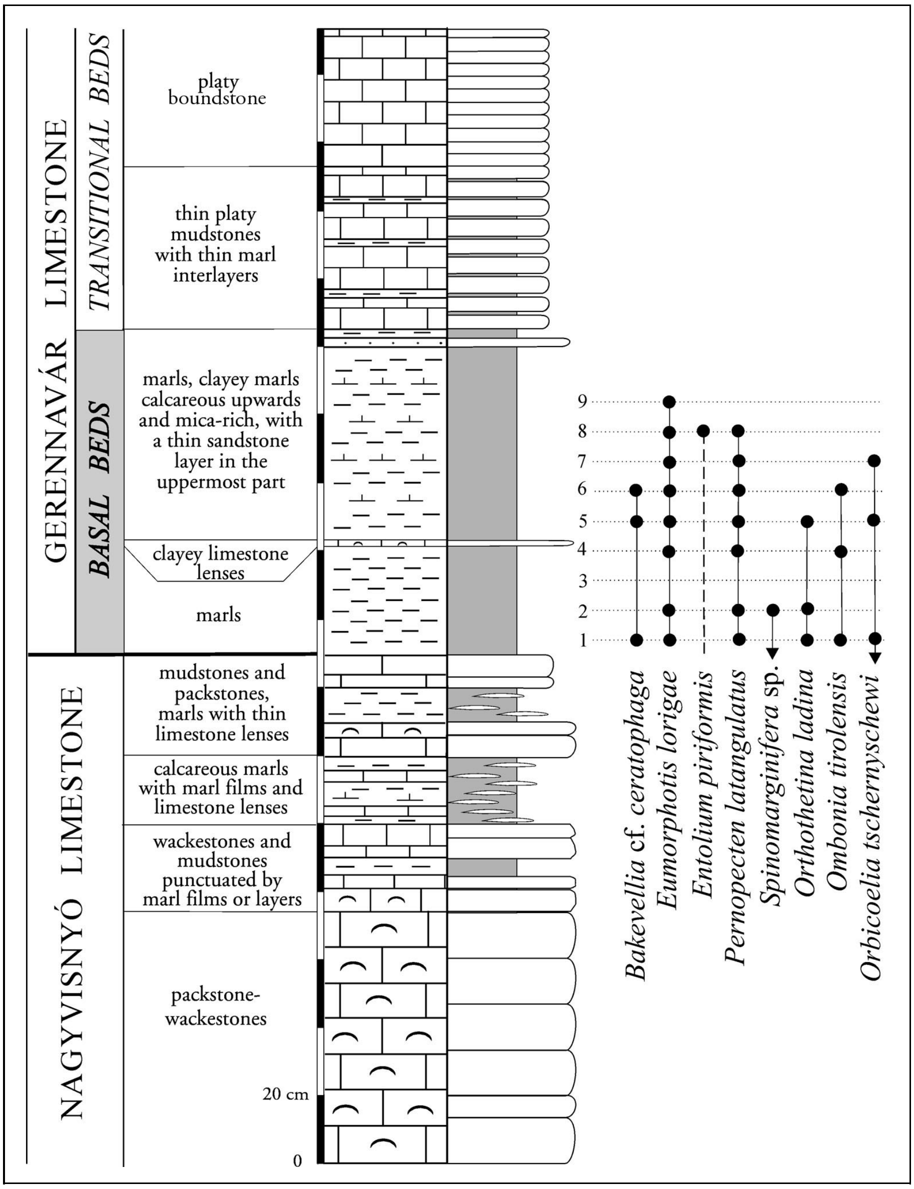


Fig. 6 - Lithologic column of the Bálvány-North section and vertical distribution of bivalves and brachiopods. The total thickness of the section is 3.35 m.

chiopod shells and the outer calcitic layer of bivalves are generally preserved. Gastropods are strongly deformed, and are represented by few internal moulds of very small, turricolate or turbinate shells, about 1 mm high, and by a single, very small internal mould of *Bellerophon*.

The specimens here studied will be deposted in Hungary, in the National Geological Museum of the Hungarian Geological Institute (Budapest).

Biostratigraphic correlation, age and conclusions

The bivalve and brachiopod species of the basal beds of the Gerennavár Limestone are mostly recorded in Permian formations. *Bakevellia* is a long-ranging Permian and Mesozoic genus (Cox 1969). *B. ceratophaga* (Schlotheim) was erected on specimens from the middle Zechstein of the Germanic Basin, but it has also been recorded in the Bellerophon Formation (Upper Permian) of the Dolomites (Merla 1930) and in several other European and Asian Permian formations (see Logan 1967).

Eumorphotis lorigae sp. n. shows strong affinities with the "Aviculopectinidae ind." (see Broglio Loriga et al. 1988, pl. 2, fig. 12, 13) contained in the marly layers of the lower Tesero Member (Werfen Formation), belonging to the Upper *praeparvus* Zone (uppermost Permian) of Perri & Farabegoli (2003). The Dolomites specimens are mostly represented by composite moulds of left valves in which spines are not preserved, but the occurrence of knots on the ribs may indicate their possible occurrence. Since Dolomites and Hungarian specimens have the same outline and ornamentation pattern, the "Aviculopectinidae ind." of the lower Tesero Member could be referred to *Eumorphotis lorigae*, although a more careful morphological analysis is necessary before deciding their generic and specific determination.

In the Dolomites, the "Aviculopectinidae ind." bearing beds are situated from 0.5 to 2 m above the formational boundary, in the different sections, inside the Upper *praeparvus* Zone. These bivalves are common in those sections (e.g. Sass de Putia, bed PK 58 of Broglio Loriga et al. 1988, and Bulla, bed BU 10 of Farabegoli & Perri 1998) where brachiopods are rare or missing. Whereas, they are rare in the corresponding *Crurithyris* (= *Orbicoelia*) beds of the Tesero section.

Entolium piriformis (Liu) and *Pernopecten latangulatus* Yin are both recorded in the Changhsingian Dalong Formation from South China (Yin 1982). Entoliidae are also recorded in the upper Bellerophon Formation [e.g. *Pernopecten tirolensis* (Stache)] and in the *Hindeodus praeparvus* Zone of the lower Tesero Member in the Tesero section (e.g. ? *Pernopecten* sp., Beretta et al. 1999, pl. 5, fig. 5). *Entolium* cf. *discites* (Schlotheim) and *Eumorphotis waageni* (Wittenburg) are recorded in the *Hindeodus parvus* and *Isarcicella isarcica* zones of the middle Dolomite Unit of the Kathwai Member, while *Eumorphotis venetiana* (Hauer) is quoted in Member E (Unit E_2, *Otoceras woodwardi* beds of which the upper part belongs to the *parvus* Zone) of the Khunamuh Formation in Kashmir (Nakazawa 1981; Kapoor 1996).

The brachiopod fauna from the basal beds of the Gerennavár Limestone has strong affinities with those from the lower Tesero Member (Werfen Formation) of the Dolomites, and in the Dolomite unit of the Kathwai Member (Mianwali Formation, Pakistan). In the latter unit, fourteen brachiopod species were reported (Grant 1970); and among them, *Crurythyris* ? (= *Orbicoelia*) *extima* Grant, *Spinomarginifera* sp., *Orthothetina* cf. *arakeljani* Sokolskaya, *Orthothetina* sp. and *Ombonia* sp. are present. All these species occur in the lower unit (according to the subdivision of the Kathwai Member of the Pakistani-Japanese Research Group 1985), which has been considered "pre-*parvus*" in age (latest Permian) by Wignall et al. (1996); only *Orbicoelia extima* and *Spinomarginifera* sp. are also recorded in the *Ophiceras* beds (? upper unit, *Isarcica* Zone, Lower Induan). As concerns the rich brachiopod fauna of the Upper Changhsingian from South China (Xu & Grant 1994), only a single brachiopod genus (*Orthothetina*) is shared.

In the Dolomites, the *Orthothetina ladina* (Stache) and *Ombonia tirolensis* (Stache) association occurs at the base of the Tesero Member (= transitional beds of Posenato 2001, Lower *praeparvus* Zone of Perri & Farabegoli 2003), while only the latter species is also present, even if very rare, in the "mixed fauna beds" (Upper *praeparvus* Zone of Perri & Farabegoli 2003), where abundant O*rbicoelia extima* and rare *Spinomarginifera* sp. occur (Beretta et al. 1999).

The fauna of the basal beds of the Gerennavár Limestone is characterized by the *Ombonia* and *Orthothetina* association, while *Orbicoelia* is represented by large sized specimens belonging to *Orbicoelia tschernyschewi* (Likharew), a Permian species with a wide stratigraphic and geographic distribution (e.g. Fantini Sestini 1965b, c; Kotlyar et al. 2004), and therefore different from the small sized specimens of *Orbicoelia extima* from the lower Tesero Member. For these reasons, the basal beds of the Gerennavár Limestone could have a slightly older age (? Lower *praeparvus* Zone) in comparison with the *Orbicelia extima* (= mixed fauna *Auct.*) beds of the lower Tesero Member (Upper *praeparvus* Zone). The *Ombonia* and *Orthothetina* association is also recorded in the uppermost Changhsingian Lower Kathwai Member of Pakistan (Wignall et al. 1996) and thus with the same age of the lower Tesero Horizon.

In conclusion, the bivalve and brachiopod fauna from the basal beds of the Gerennavár Limestone is latest Permian in age, and probably belonging to the Lower *praeparvus* Zone of Perri & Farabegoli (2003). However, a precise age determination of the fauna requires a conodont investigation which is not yet available. On the basis of the suggested age, the basal Gerennavár Limestone of the Bálvány-North section is one of the few units in the world which records the bioevents connected with the P/T mass extinction.

spec.	sbl	valve	Height	Length	H/L
1	1	R	4.9	9.2	0.53
2	5	L	12.3	17.2	0.71
3	6	L	8.4	12.3+	0.68
4	5	L	8.5	11.3+	0.75

Tab. 1 - Measurements in mm of *Bakevellia* cf. *ceratophaga* (Schlotheim). Abbreviations and symbols: H/L – height and length ratio; L – left valve; R – right valve; sbl – sublayer; spec. – specimen number; + – measurement of incomplete specimen.

Systematic description (R. Posenato)

Bivalvia

Order **Pterioida** Newell, 1965

Suborder **Pteriina** Newell, 1965

Superfamily Pteriacea Gray, 1847

Family Bakevelliidae King, 1850

Genus *Bakevellia* King, 1848

Bakevellia cf. **ceratophaga** (Schlotheim, 1816)

(Pl. 1, Fig. 11)

Material. Three left valves and one right valve, all strongly flattened by compression (Tab. 1).

Description. Small sized shell, aviculiform, subrhomboidal, with growth lines or fine concentric lamellae; auricles well defined from body, anterior auricular sulcus deep, anterior auricle large, posterior wing long, slender and with pointed tip, broad and deep posterior sinus. Internal characters not preserved.

Remarks. These specimens are classified in open nomenclature as they are badly preserved. Flattening of the shell, caused by sediment compression, has distorted the angle between the hinge line and mid umbonal line, and does not permit the original inflation degree of the shell to be defined. Values of the H/L ratio are similar to those of *B. binneyi* (Brown, 1841) (= *Avicula antiqua* Münster, 1836) which is about 0.7, while *B. ceratophaga* has a more oblique valve with values of 0.6 or less (Logan 1967). However, the former species has ears not well separated from the shell and an obtuse posterior auricle. For this reason the specimens are here compared to *Bakevellia ceratophaga*.

Order **Pectinoida** Newell & Boyd, 1995*

(*Pectinoid description and classification is made following Newell & Boyd, 1995)

? Superfamily Pterinopectinacea Newell, 1938

? Fam. Pterinopectinidae Newell, 1938

? Pterinopectinidae gen. et sp. indet.

(Pl. 1, Fig. 10)

Material. A single fragment of valve, visible on the inner surface, is available (specimen no. 32, sublayer 4). It is represented by the middle ventral portion of a strongly flattened valve, about 28 mm long, of which only the thin calcitic outer layer is preserved.

Description. The preserved portion has a semiovoidal outline and an ornamentation consisting of low, narrow concentric wrinkles, which are clearly detectable on the lateral regions, and irregular radial ribs occurring on the left side.

Remarks. This poorly preserved, incomplete specimen has an outline and ornamentation quite different from the other bivalves here described. It shows some

spec.	sbl	valve	Height	Length	hml	hml/L
5	5	R	27.5	-	13.6+	-
6	9	L	35.8	-	-	-
7	4	L	20.5	19.0+	11.6+	-
8	9	L	33.8	28.9	22.8+	-
9a	1	R	14.0+	23.3+	21.6+	-
9b	1	L	25.5	30.4	-	-
11	debr	L	20.5+	28.4	22.7	0.80
12	debr	L	32.5+	43.2	-	-
13	debr	L	24.0	27.8	21.2	0.76
14	debr	L	14.0	18.7	15.2	0.81
15	5	L	27.8	33.5+	-	-
16	4	R	13.2+	15.0	12.4	0.83
17	debr	R	24.5	26.8	21.6	0.81
18	debr	L	-	25,8+	18.8	-
19	debr	L	26.5+	25.8+	16.8	-

Tab. 2 - Measurements in mm of *Eumorphotis lorigae* sp. n. Abbreviations: debr – debris; hml – length of the cardinal margin; hml/L – length of cardinal margin and length of valve ratio. For the others abbreviations and symbols see Tab. 1.

similarities with *C. primitiva* Yin 1982 from the uppermost Permian of China (Yin 1982, 1985), even if this species has a coarser concentric ornamentation, and, in particular, with *C. dieneri* Nakazawa, 1977 from the upper unit E_2 (*Hindeodus parvus* Zone) of Khunamuh Formation (Guryul Ravine section, Kashmir) (Nakazawa 1981; Kapoor 1996). Incompleteness and orientation of valve (inner side) impede any other comparison and a sure determination.

Superfamily Aviculopectinacea Meek & Hayden, 1864
Family Etheripectinidae Waterhouse, 1982
Subfamily Etheripectininae Waterhouse, 1982
Genus *Eumorphotis* Bittner, 1901

Eumorphotis lorigae sp. n.

(Pl. 1, Figs 1-9)

Derivatio nominis. Dedicated to the memory of Prof. Carmen Broglio Loriga for her contributions to the knowledge of Triassic and Jurassic bivalves. She worked with us, some years ago, in the Bálvány-North section to collect part of the material studied here.

Holotype. Specimen no. 13, a left valve.

Paratypes. A complete shell (no. 9), four right valves and ten left valves (see Tab. 2). Several other incomplete and deformed valves are also available.

Age. Latest Changhsingian.

Horizon and locality. Basal beds of the Gerennavár Limestone; Bálvány-North section.

Diagnosis. Slightly prosocline, inequiconvex and discrepant pectinoid. Hinge margin straight and a little shorter than shell length. Posterior auricle not differentiated from disc and with a slightly protruding, pointed ear. Left valve inflated and strongly ribbed with three orders of ribs increasing by intercalation, and with about 13 spinose ribs of first order. Right valve flat with crowded weak riblets; anterior auricle pointed with a deep, unconstricted byssal notch.

Description. The most common and long ranging taxon is represented by middle sized (max. height = 40 mm), retrocrescent pectinoids with inequiconvex, multicostate, discrepant valves. The hinge margin is straight, about 4/5 the shell length. Costae bear hyote spines which are mostly developed on the posterior region and along the dorsal posterior margin. The costae of the left valve are divided into three ranks by intercalation; costae of first rank are about 13. Posterior auricle of left and right valves not well differentiated from disc and with a shallow auricular sinus.

Right valve is flat, with a subdued ornamentation made up of shallow, smooth or weakly spinose and scaly bifurcate costellae. Anterior auricle clearly differentiated from disc and with about 6-7 scaly ribs. The dorsal extremities of anterior and posterior auricles are acuminate. Byssal notch is deep and not constricted; posterior auricular sulcus shallow.

Remarks. Only the external characters are available for the classification of these pectinoids, because only the external calcitic layer is preserved, while the inner aragonitic layers are dissolved. The shell outline is similar to that of the Pterinopectinacea, however, this superfamily is characterized by concordant shell (Newell & Boyd 1995). According to the recent revision of Pectinoids by Newell & Boyd (1995), these bivalves can be classified into the subfam. Etheripectininae which comprises the two genera *Heteropecten* Kegel & Costa and *Eumorphotis* Bittner. Spinose ribs characterize the left valve of the Late Permian *Paradoxipecten* Yin, a genus considered a juvenile synonym of *Heteropecten* by Newell & Boyd (1995). However, the latter genus has left posterior auricle well differentiated from the disc and deep auricular sinuses. The present specimens have the posterior auricle almost undistinguished from the body and shallow posterior auricular sulcus, which allows us to determine them as *Eumorphotis* Bittner. These characteristics are also present in *Pseudomonotis* Beyrich (Superfam. Pseudomonotacea), which however has a distally constricted byssal notch, short hinge, obtuse and rounded posterior auricle, without pointed ears (Newell & Boyd 1970).

On the basis of ornamentation, the present material shows strong similarities with *Pseudomonotis subangulata* Yin, 1982 (Yin 1982, pl. 31, fig. 7-9) from the Changhsingian Dalong Fm., a species whose classification into *Eumorphotis* cannot be excluded because it does not show a clear distal constriction of the byssal notch. Moreover, the length of its hinge margin is about 2/3 of shell length (Yin 1982), while in the type-species of *Pseudomonotis* [*P. speluncaria* (Schlotheim, 1816)] the hinge margin of adult shells is about ½ of shell length. However, Yin's species is characterized by a subangular antero-dorsal corner on the right valve, which is lacking in our specimens. *Etheripecten haydeni* Nakazawa, 1981 has first order costae with spines, but this species, from the uppermost Permian unit E_1 of Khunamuh Formation (Guryul Ravine section, Kashmir) (Nakazawa 1981; Kapoor 1996), is characterized by a short and well differentiated posterior auricle, which justify its classification into a different genus. Moreover, the holotype of Nakazawa's species (Nakazawa, 1981, pl. 9, fig. 10) has more dense radial ribs, which are separated by narrower interspaces.

These pectinoids are very similar to *Eumorphotis beneckei* (Bittner 1901) figured by Leonardi (1930, pl. 1, fig. 1). This is an incomplete left valve with twelve first order ribs with scales or hyote spines; it was collected from the *Ombonia* beds of Tesero (Dolomites). The holotype of *E. beneckei* (Bittner) comes from the Anisian (? Pelsonian) "Muschelkalk" of Northern Dolomites (Braies/Prags), but the species is also recorded in the Lower Triassic (Wittenburg 1908; Broglio Loriga

spec.	sbl.	valve	Height	Length	H/L	Umb. angle	hml	hml/L
20	8	L	10.9	9.4	1.16	85°	3.2	0.34

Tab. 3 - Measurements in mm of *Entolium piriformis* (Liu). Abbreviations: Umb. angle – umbonal angle; for the others abbreviations and symbols see Tab. 1 and 2.

& Mirabella 1986). The holotype has first order ribs narrower and more numerous than our pectinoids and the byssal notch is distally constricted, thus our material does not pertain to Bittner's species. For these reasons the new species *E. lorigae* is here proposed.

Superfamily Pectinacea Wilkes, 1810

Family Entoliidae von Teppner, 1922

Entolium piriformis (Liu, 1976)

(Pl. 2, Fig. 7)

1976 *Pernopecten piriformis* Liu, p. 206-207, pl. 15, fig. 15-16

Material. One internal mould with shell fragments along ventral margin of a left valve (Tab. 3).

Description. Small sized left valve, subovoidal, ventrally elongated, infracrescent, subequilateral with a radial sulcus on the rear region of the disc. The ornamentation consists exclusively of crowded growth lines detectable only on the shell fragments along the ventral and anterior margins. The auricles are small, triangular, not projecting above hinge margin; byssal notch absent.

Remarks. The taxonomy of the Late Permian Entoliidae is rather confused, as they often have transitional features between the Carboniferous–Early Permian *Pernopecten* and the Triassic *Entolium* (Newell 1937; Allasinaz 1972; Yin 1982) which impede a clear morphological distinction from being drawn between them. The morphology of this pectinoid is strictly related to *Pernopecten piriformis* Liu (in Nanjing Institute of Geology and Paleontology ed. 1976), a Late Permian Chinese species placed by Yin (1982) into the genus *Entolium*.

Pernopecten latangulatus Yin, 1982

(Pl. 2, Figs 1-6)

1982 *Pernopecten latangulatus* Yin, p. 368, pl. 33, fig. 4, 5, 7, 8.

Material. Several specimens are available but only few are relatively well preserved: seven right valves, three left valves, and one still articulated shell which lacks the anterior auricles (Tab. 4).

Description. Acline shell with a subcircular disc, nearly symmetrical. H/L ratio 0.86-1.08, umbonal angle 95-115°. The hinge margin of right valve is straight, as well as probably that of left valve too. Anterior margin forward projected further than the anterior auricle extremity. Slightly asymmetrical auricles. The front margin of anterior right auricle is convex, and below the auricle there is a distinct, but not deep, byssal sinus. Posterior right auricle obtuse with a convex or straight rear margin. The shell is smooth, or with fine and dense growth lines. Internal characteristics unpreserved.

Remarks. Following the criteria proposed by Yin (1982) to distinguish *Pernopecten* from *Entolium*, the occurrence of a shallow byssal sinus allows us to attribute these specimens to the gen. *Pernopecten*, even if they show intermediate features (e.g. not acuminated left ears) between the two genera, as frequently occurs in the Upper Permian Entoliidae (see Yin 1982 for discussion). This pectinid is referred to *Pernopecten latangulatus* Yin, from which it differs in its larger size. A single isolated left valve (no. 28: Pl. 2, Fig. 8) shows some differences with respect to the other above described specimens. The shell is prosocline, has feebly

spec.	sbl.	valve	Height	Length	H/L	Umb. angle	hml	hml/L
21	4	R	13.6	13.3	1.05	95	6.1	0.46
22	2	R	-	21.8	-	115	9.3	0.43
23	-	R	14.6	16.0	0.91	95	6.9	0.43
24	-	R	11.8	11.3	1.04	105	6.1	0.53
25	4	R	12.8	11.8	1.08	105	6.1	0.52
26	6	R	15.2	16.6	0.91	100	7.2	0.43
27	1	R	10.2	9.8	1.04	95	5.5	0.51
28 (?)	5	L	21.2	18.1	1.17	110	9.4	0.52
29	1	L	-	15.2	-	-	6.3	0.41
30	-	L	-	12.7	-	100	-	-
31	4	B	14.7	17.1	0.86	115	-	-

Tab. 4 - Measurements in mm of *Pernopecten latangulatus* Yin. Symbols: B- articulated shell. For the others abbreviations and symbols see Tab. 1-3.

irregular radial plications, and the anterior margin of the disc does not extend beyond the anterior auricle. On the basis of the sculpture, it shows similarities with the Triassic genus *Entolioides* Allasinaz, characterized by a discrepant ornamentation with smooth RV and multicostate LV (Newell & Boyd 1995), of which it could represent a primitive form. However, we have only a single left valve whose deformation cannot be excluded. Further material is thus necessary to define the nature (genetic or diagenetic origin) of the radial "ornamentation" of this specimen, which is therefore determined here in open nomenclature as Entoliidae gen. et sp. undetermined (Pl. 2, Fig. 8).

spec.	sbl	valve	Length	Width
33	2	B	18.6	19.4+
34	2	B	16.5+	21.7+

Tab. 5 - Measurements in mm of *Spinomarginifera* sp. For abbreviations and symbols see Tab. 1, 4.

Brachiopoda

Order **Productida** Sarytcheva & Sokolskaya, 1959
Suborder **Productidina** Waagen, 1883
Superfamily Productoidea Gray, 1840
Family Productellidae Schuchert, 1929
Subfamily Marginiferinae Stehli, 1954
Tribe Marginiferini Stehli, 1954
Genus *Spinomarginifera* Huang, 1932

Spinomarginifera sp.

(Pl. 2, Fig. 9)

Material. Two articulated shells (nos. 33, 34), both collected from sublayer 2 (Tab. 5).

Description. Both shells are strongly deformed, with the dorsal valves almost completely covered by sediment. Ventral valve convex, without median sulcus and wholly covered by thin (about 0.1 mm in diameter) and relatively spaced (1-2 mm) spines, which are evenly distributed in the anterior half of the valve. Ventral ribbing is absent, and only elongated spine bases are detectable. Lateral extremities of shell and hinge margin are not detectable as both specimens are broken. A part of the cardinal margin, preserved in specimen no. 34, allows us to suppose that this productid could have a wide cardinal margin. Dorsal disc visible only on the umbonal region of specimen no. 34; it is concave, with only shallow and irregularly spaced pits. There are no traces of dorsal trail along anterior margin, thus we can assume that it was probably short. Interior of ventral valve without median septum; the cardinal process, detectable inside the sectioned ventral umbo of specimen no. 33, is bilobed.

Remarks. Absence of ventral median septum excludes their classification into the genus *Tschernyschewia*, which frequently occurs in the underlying Nagyvisnyó Fm. (Schréter 1963).

Several characters (i.e. absence of ribbing, the supposed short dorsal trail and wide hinge, and absence of dorsal spines) suggest these productids should be placed into the genus *Spinomarginifera*, which is recorded in several sections near the P/Tr boundary [e.g. Salt Range (Grant 1970), South China (Liao 1980), and Dolomites (Neri & Pasini 1985)]. They show affinities with *Spinomarginifera intermediahelica* (Abich, 1878), a species already recorded in the Upper Permian Nagyvisnyó Fm. of the Bükk Mountains (Schréter 1963), and with some Chinese species (e.g. *S. alpha* Huang, 1932 from the Changhsingian of South China), though deformation and incompleteness of the shells prevent the specific determination.

Order **Orthotetida** Waagen, 1884
Suborder **Orthotetidina** Waagen, 1884
Superfamily Orthotetoidea Waagen, 1884
Family Meekellidae Stehli, 1954
Subfam. Meekellinae Stehli 1954
Genus *Orthothetina* Schellwien, 1900

Orthothetina ladina (Stache, 1878)

(Pl. 2, Figs 10-13)

v 1878? *Orthis ladina* Stache, p. 158, pl. 4, fig. 18 a-c.
v 1930 *Ombonia ventilabrum* Leonardi, p. 7, pl. 1, fig. 6, 7.
v 1988 *Orthothetina ventilabrum* - Broglio Loriga et al., pl. 1, fig. 7.
v 1988 *Orthothetina ventilabrum* - Posenato, pl. 1, fig. 3b; pl. 2, fig. 2.

Material. One articulated shell, three ventral valves, one dorsal valve. All the specimens are flattened, and sometimes laterally deformed (no. 39) by diagenetic processes. They were collected from the sublayers 1 and 5 (Tab. 6).

Description. Small sized and low conical, not plicated, but costellate shell. The cardinal margin is about $^{3}/_{4}$ of the greatest width. Both valves are covered by costellae with acute, slightly crenulated crests. Interspaces are broader than costellae and covered by dense, regularly spaced, very thin growth lines. Costellae are about 18 of first order near the apex and increase mostly by intercalation; bifurcation seems to be restricted to the early growth stages. In specimen no. 35, costellae

spec.	sbl	valve	Length	Width	cw	ih	L/W	cw/W
35	5	V	6.5	8.2	5.6	1.4	0.79	0.68
36	-	V	8.9	7.5+ (13.0)	5.9+ (9.2)		0.68	0.71
37	1	B	12.4+	18.3	-		-	-
38	1	V	22.7	27.2	-	2.9	0.83	-
39	5	?D	12.5	16.2	11.0		0.77	0.68

Tab. 6 - Measurements in mm of *Orthothetina ladina* (Stache). Abbreviations and symbols: cw – width of cardinal margin; D – dorsal valve; ih – height of interarea; L/W – length and width of valve ratio; V – ventral valve; (xx) – estimated measurement of incomplete specimen. For the others abbreviations and symbols see Tab. 1-5.

number 11 per 5 mm at the anterior margin, of which 6 are of first order and 5 of minor order.

Interarea low, long, about ¼ of the hinge width. Ventral valve interior with dental plates, which are dorsally divergent and reach the floor of ventral valve without joining.

Remarks. Stache (1878), in his monograph on the molluscs and brachiopods of the Bellerophon Formation from South Tyrol (Dolomites), included several species in the genera: *Productus*, *Streptorhynchus*, ?*Orthis* and *Strophomena*. Stache (1878) placed into the latter genus only the ventral valves, whereas almost completely the dorsal valves (sometimes by him erroneously considered as ventral) were included in the other genera. However, as already noted by Caneva (1906a) and Merla (1930), the generic attribution of Stache was not correct because the internal characters of the shell were not considered in the classification, and Stache (1878) erroneously considered as ventral valves of Productids the dorsal valves of Orthotetoids. For this reason, the above quoted authors suggested to place Stache's species into the genus *Ombonia* Caneva, which was the only Orthotetoid genus so far known in the Bellerophon Formation at that time. More recently, a second Orthotetoid genus (*Orthothetina*) has been discovered in the brachiopod fauna of the uppermost Bellerophon Formation (Broglio Loriga et al. 1988). The distinction between *Ombonia* and *Orthothetina* is mostly based on the different arrangement of the dental plates, which form a Y-shape spondylium in the former genus, whereas they are separated and dorsally divergent in the latter genus (see Posenato 1988, pl. 2, fig. 2). Besides, the Dolomites specimens of these two genera are also distinguishable on account of the shell sculpture. *Orthothetina* specimens have fine costellae with acute, crenulated crests, separated by relatively wide interspaces in which dense and regularly spaced growth lines occur. Among Stache's specimens a dorsal valve, with only the left lateral region preserved, shows the typical ornamentation of *Orthothetina* from the Dolomites and Bükk Mountains. This specimen is the holotype of ?*Orthis ladina* Stache (GBA cat. no. 1878/1/62), thus the present material is referred to the species *Orthothetina ladina* (Stache).

In the Dolomites, the *Orthothetina* specimens have until now been referred to *O. ventilabrum* (Leonardi 1930) (e.g. Posenato 1988) which, on the base of the examination of Stache'collection, must be considered a junior synonym of *Orthothetina ladina* (Stache). This species, with *Ombonia*, occurs in the uppermost Bellerophon Formation and basal Tesero Member (Werfen Fm.) of the Dolomites (e.g. Broglio Loriga et al. 1988; Beretta et al. 1999; Posenato 2001).

spec.	sbl	valve	Length	Width	cw	ih	Th	L/W	cw/W
40	6	B	12.2	15.0	10.5	3.0	7.2	0.81	0.70
41	6	V	9.3+	12.7+	7.9	2.0	2.5	-	-
42	6	D	12.7	17.1	-	-	3.5	0.74	-
43	4	D	-	17.5	-	-	-	-	-
44	1	V	-	21.1	-	-	-	-	-

Tab. 7 - Measurements in mm of *Ombonia tirolensis* (Stache). Th – thickness. For the others abbreviations and symbols see Tab. 1- 6.

Subfam. Omboniinae Sokolskaya, 1960

Genus *Ombonia* Caneva, 1906a

Ombonia tirolensis (Stache, 1878)

(Pl. 2, Figs 15, 16)

v 1878 *Streptorhynchus tirolensis* Stache 1878, p. 159, pl. 4, fig. 17 a-c.
v 1878 *Productus cadoricus* Stache 1878, p. 163, pl. 4, fig. 13 a-c.
v 1878? *Productus Stotteri* Stache 1878, p. 165, pl. 4, fig. 16 a-c.
v 1878 *Streptorhynchus Pichleri* Stache 1878, p. 161, pl. 4, fig. 19 a-c.
v 1930 *Ombonia canevai* Merla, p. 80, pl. 7, fig. 13-21.
1958 *Orthotetes* (*Ombonia*) *canevai* - Kostic-Podgorska, p. 44, pl. 7, fig. 4, 7.
v 1988 *Ombonia canevai* - Broglio Loriga et al., pl. 2, fig. 1, 2.
v 1988 *Ombonia canevai* - Posenato, pl. 1, fig. 4, pl. 2, fig. 1, 3

Material. One articulated shell, two ventral valves and two dorsal valves collected from the sublayers 1, 4 and 6 (Tab. 7).

Description. Small sized, low conical shell. The cardinal margin is shorter than the greatest width. Ventral valve is conical, not distorted in the articulated specimen, and with a low apsacline interarea; pseudodeltidium narrowly arched. The brachial valve is strongly inflated, with maximum convexity located in the middle-posterior region. Ventral valves are not plicate but covered by dense, fine costellae, which number 25/30 in the umbonal region, increasing by intercalation towards anterior and lateral regions. Along the middle anterior margin there are about 15-17 costellae of different orders per 5 mm. The crests of costellae are rounded and the interspaces are narrower than themselves. Ventral valve interior with a Y-shaped spondylium.

Remarks. As so far suggested by Caneva (1906a) and Merla (1930), the specimens included by Stache (1878) into the genera *Productus*, *Streptorhynchus*, ?*Orthis* and *Strophomena* must be considered dorsal valves of *Ombonia*. When Caneva (1906a) erected the genus *Ombonia*, he did not describe or quote any species belonging to his new taxon. In another paper, Caneva (1906b) wrote that in his collection, from the Bellerophon Formation, *Ombonia* can be represented by at least 8-10 species. Later, Merla (1930), studying Caneva's collection, recognized only a single (and new) species (*Ombonia canevai*) which has become the type-species of *Ombonia* (e.g. Williams & Brunton 2000).

Stache (1878) used a strictly typological concept of species which were generally erected using a single specimen. Species distinction was based on small differences of the valve outline and ornamentation pattern, which can mostly be attributed to intraspecific variability or as being caused by diagenetic deformation (Posenato 1998). After the examination of his type-specimens we consider the following "species" of Stache - *Productus cadoricus* (a dorsal valve), *Streptorhynchus tirolensis* (a dorsal and a ventral valve with the spondylium), *S. pichleri* (ventral valve interior), and ?*Productus stotteri* (a dorsal valve) - as belonging to a unique species of *Ombonia*, which is here named *Ombonia tirolensis*. Stache (1878) erected this species on a dorsal valve (Stache 1878, pl. 4, fig. 17a-c), but he tentatively also assigned to the species a ventral valve (Stache 1878, pl. 4, fig. 23). Only the latter specimen is preserved in the Austrian collection (GBA, cat. no. 1878/1/63 and labelled as *holotypus monotypicus*). It has the typical ornamentation and valve outline of *Ombonia*, and in the broken umbonal region, the dental plates forming a Y-shaped spondylium are clearly detectable. Therefore, *O. canevai* Merla must be considered as junior synonym of *O. tirolensis*, which thus becomes the type-species of *Ombonia* Caneva.

This species, formerly determined as *Ombonia canevai* Merla, is frequent in the transitional beds (*Ombonia* and *Orthothetina* beds) from the Bellerophon and Werfen formations of the Dolomites belonging to the Lower *praeparvus* Zone (uppermost Changhsingian) of Perri & Farabegoli (2003).

spec.	sbl	valve	Length	Width	cw	Th	L/W	cw/W
45	7	B	10.7	11.3	6.5	6.9	0.95	0.58
46	7	B	10.1	9.8	5.9	6.4	1.03	0.60
47	-	B	8.6	9.5	5.2	5.4	0.91	0.55
48	5	B	6.4	6.8	4.4	3.3	0.94	0.65
49	-	V	4.0	4.4	-	2.6	0.91	-

Tab. 8 - Measurements in mm of *Orbicoelia tschernyschewi* (Likharew). For abbreviations and symbols see Tab. 1-7.

Order **Spiriferida** Waagen, 1883
Suborder **Spiriferidina** Waagen, 1883
Superfamily Cyrtioidea Frederiks, 1924
Family Ambocoeliidae George, 1931
Genus *Orbicoelia* Waterhouse & Piyasin, 1970

Orbicoelia tschernyschewi (Likharew, 1939)

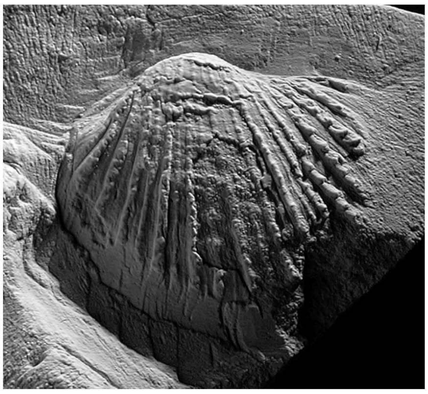
(Pl. 2, Fig. 14)

1900 *Spirifera (Martinia) planoconvexa* - Arthaber, p. 266.
1902 *Ambocoelia planoconvexa* - Tschernyschew, p. 575, pl. 20, fig. 1; pl. 49, fig. 7.
1912 *Ambocoelia planoconvexa* - Yakowlew, p. 31, pl. 5, fig. 4, 7, 14.
1933 *Ambocoelia planoconvexa* - Simic, p. 100, pl. 4, fig. 2-4.
1939 *Ambocoelia (Crurithyris ?) tschernyschewi* Likharew, p. 114, pl. 25, fig. 11.
1958 *Ambocoelia planoconvexa* - Kostic-Podgorska, p. 55.
1958 *Crurithyris planoconvexa* - Ramovs, p. 535.

PLATE 1

Bivalves from the basal beds of the Gerennavár Limestone, Bálvány-North section.

Figs. 1-9 - *Eumorphotis lorigae* n. sp. (x 1.5). 1) Holotype, left valve with the outer calcitic layer almost entirely preserved; this specimen (no. 13), even if slightly deformed, shows an original strong inflation of the left valve; 2) left valve with shell fragments on the dorsal margin, specimen no. 18; 3) inner view of left valve, specimen no. 19; 4) interior view of right valve; it belongs to an articulated specimen of which the interior left valve is shown in Fig. 5, specimen no. 9; 6) internal mould of a compressed, due to sediment compaction, left valve, specimen no. 15; 7) a large and flattened left valve; shell remains on the posterior region allow us to detect hyote spines on the ribs, specimen no. 12; 8) interior view of a left valve, specimen no. 11; 9) external cast of a strongly flattened left valve.
Fig. 10-? - Pterinopectinidae gen. et sp. indet., internal view of a right valve (?), specimen no. 32 (x 1,5).
Fig. 11 - *Bakevellia* cf. *ceratophaga* (Schlotheim, 1816), internal view of a strongly flattened left valve, specimen no. 2 (x 2).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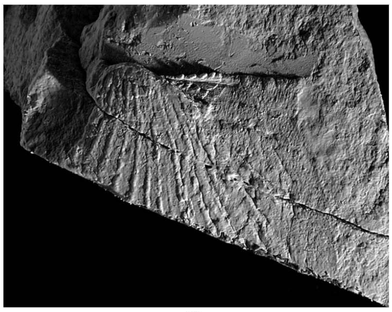
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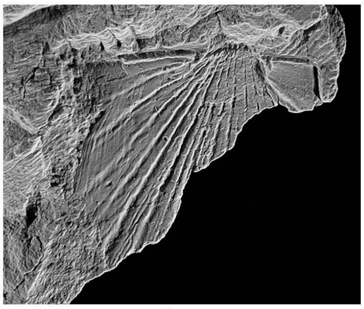
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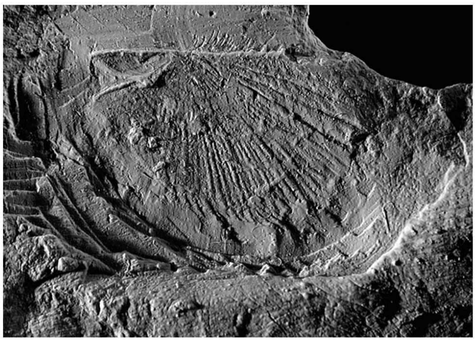
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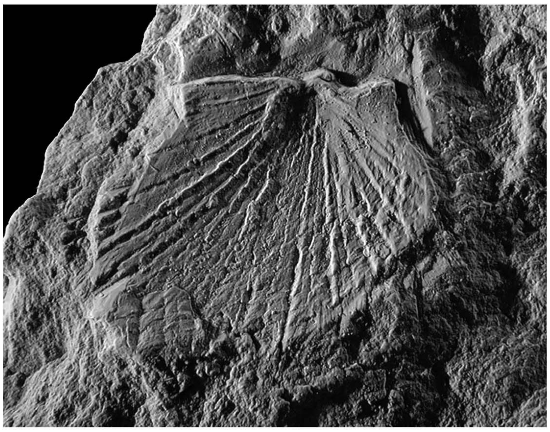
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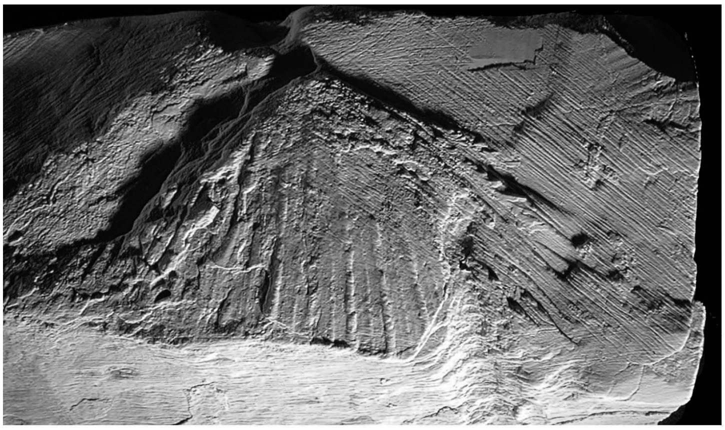
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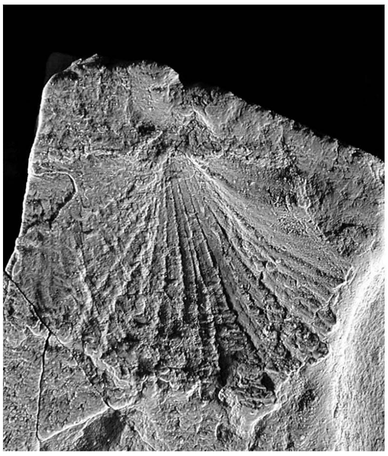
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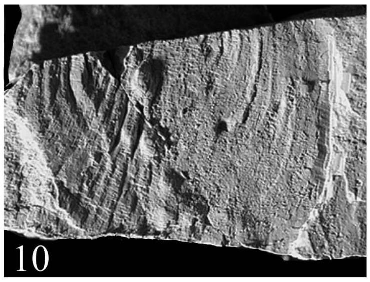
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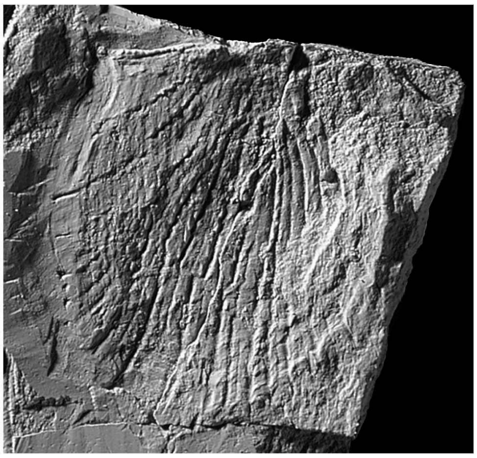
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1963 *Ambocoelia* (*Crurithyris*) *tschernyschewi* - Schréter, p. 134, pl. 7, fig. 7-11.
1965b *Crurithyris tschernyschewi* - Fantini Sestini, p. 62, pl. 7, fig. 1 a-c.
1965c *Crurithyris tschernyschewi* - Fantini Sestini, p. 785.
1970 *Orbicoelia tschernyschewi* - Waterhouse & Piyasin, p. 147.
1976 *Orbicoelia tschernyschewei* - Waterhouse, p. 157, 161.
2004 *Crurithyris tschernyschewi* - Kotlyar et al., p. 516.

Material. 13 articulated shells collected in the sublayers 5 and 7 (Tab. 8).

Description. Medium-large size for genus, with a roundly subpentagonal to subelliptical outline; ornament consisting of weak growth lamellae. The width is near equal to the length, and the cardinal margin is shorter than the maximum width, which is placed near the posterior one-third of shell; commissure rectimarginate. The ventral valve is strongly convex, with maximum curvature in the posterior one-third, and without middle sulcus. Lateral margins form rounded angles with cardinal margin. The beak is acute, strongly curved, but not projected beyond commissural plane. The interarea is triangular in outline, concave, not clearly limited from the lateral posterior surfaces, and with a relatively large and open delthyrium bounded laterally by narrow and raised flanges. The dorsal valve is weakly inflated, with greatest convexity near the beak, which is slightly projecting beyond hinge. The dorsal interarea is very low and slightly concave with an open notothyrium, which is low and bounded by very short chilidial plates.

Remarks. These specimens have a morphology closely related to *"Crurithyris" tschernyschewi* so far described, discussed and figured by Schréter (1963) from the upper marly beds of the Nagyvisnyó Limestone (Upper Permian), and reported from several localities of the Bükk Mountains. Waterhouse & Piyasin (1970) suggested to include this species into their new genus *Orbicoelia*, due to the lacking of the middle sulcus in either valve, which represents the most important exterior taxonomical characteristic to distinguish *Orbicoelia* from *Crurithyris*.

This proposal was repeated by Waterhouse (1976), who included in *Orbicoelia* also *Crurithyris* ? *extima* Grant 1970 (see also Waterhouse 1972).

The above listed synonyms of *Orbicoelia tschernyschewi* are those so far proposed by Likharew (1939) and Fantini Sestini (1965b), with the exception of *Crurithyris tschernyschewi* of Fantini Sestini (1965a), from the Lower Permian of Karakorum, because, as already noted by Waterhouse & Piyasin (1970), in the figured specimen (Fantini Sestini 1965a, pl. 24, fig. 8) the median sulcus is present.

Orbicoelia tschernyschewi is similar to *O. extima* from the lower Kathwai Member of Pakistan (Grant 1970) and lower Tesero Horizon (Neri & Pasini 1985), but the former species has larger size, a higher interarea and a more strongly curved, more pointed ventral umbo.

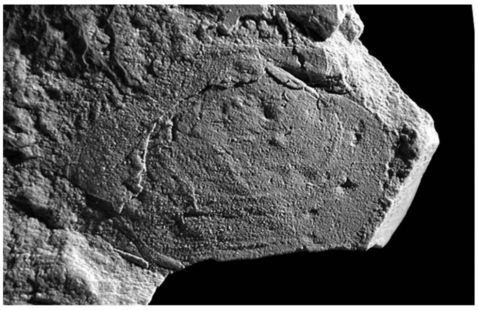
The generic distinction between *O. tschernyschewi* and Chinese Changhsingian *Crurithyris* species (i.e, *C. speciosa* Wang, 1955 and *C. pusilla* Chan, 1979) is supported by the occurrence in the latters of a narrow sulcus on the ventral valve (see Xu & Grant 1994).

Orbicoelia tschernyschewi has a wide stratigraphic and geographic distribution. It is know from the Lower Permian of North Iran (Dorud Formation, Fantini Sestini 1965b), Middle Permian of North Iran (Ruteh Formation, Fantini Sestini 1965a) and Upper Permian of Hungary (Nagyvisnyó Limestone, Schréter 1963), Slovenia (Žažar beds, Ramovš 1961), Serbia (Simić 1933) and Montenegro (Kostić-Podgorska 1958). It also occurs in the Urushten reef limestone of Northwestern Caucasus, which is now considered late Changhsingian in age (Kotlyar et al. 2004) and from the Permian succession of Djulfa (Transcaucasia), from an unknown stratigraphical position (Arthaber 1900).

PLATE 2

Bivalves and brachiopods from the basal beds of the Gerennavár Limestone, Bálvány-North section (all x 2).

Figs. 1-6	- *Pernopecten latangulatus* Yin, 1982. 1) exterior view of a right valve; the antero-posterior elongation of the specimen (no. 22) is probably due to deformation; 2) interior view of a right valve, specimen no. 27; 3) interior view of a right valve of a probably still articulated shell which left valve, slightly rotated, is represented by a small portion of the internal mould detectable on the left, anterior side, specimen no. 25; 4) internal view of a right valve, specimen no. 23; 5) left valve of an articulated shell with broken auricles, specimen no. 31; 6) interior views of two right valves, specimen no. 21.
Fig. 7	- *Entolium piriformis* (Liu, 1976), exterior view of a left valve, specimen no. 20.
Fig. 8	- Entoliidae gen. et sp. indet., exterior view of a left valve, specimen no. 28.
Fig. 9	- *Spinomarginifera* sp., ventral valve, specimen no. 33.
Fig. 10-13	- *Orthothetina ladina* (Stache, 1878); 10) ventral valve, specimen no. 35; 11) ventral view of an articulated and deformed shell, specimen no. 37; 12 – internal view of a dorsal (?) valve, specimen no. 39; 13 – internal view of a ventral valve, specimen no. 38.
Fig. 14	- *Orbicoelia tschernyschewi* (Likharew, 1939); ventral (14a), lateral (14b) and dorsal (14c) views, specimen no. 45.
Fig. 15, 16	- *Ombonia tirolensis* (Stache, 1878); 15) a ventral valve (left) and a dorsal valve of an articulated shell, specimen no. 40.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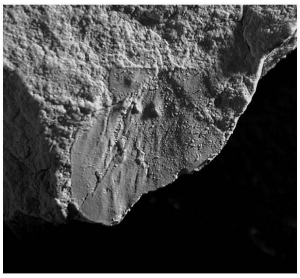
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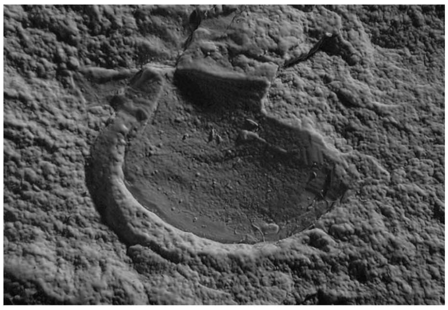
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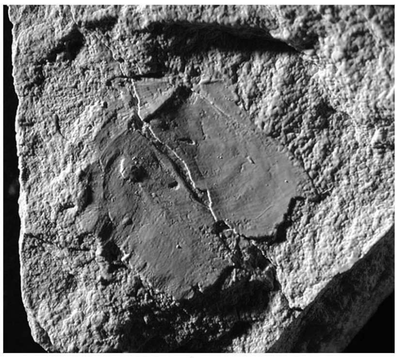
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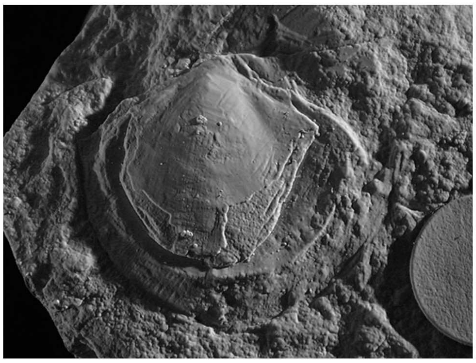
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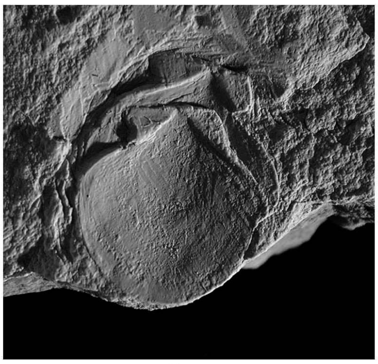
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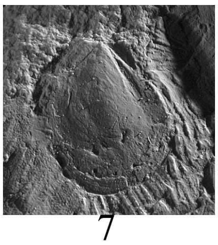
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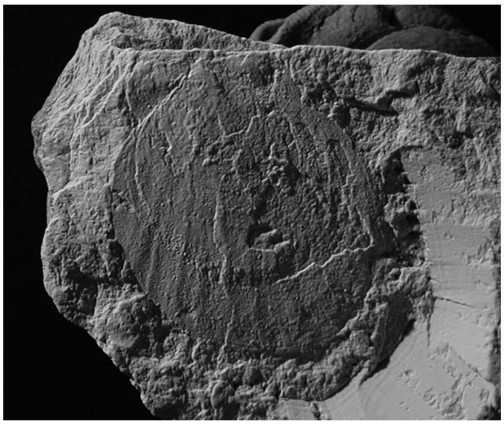
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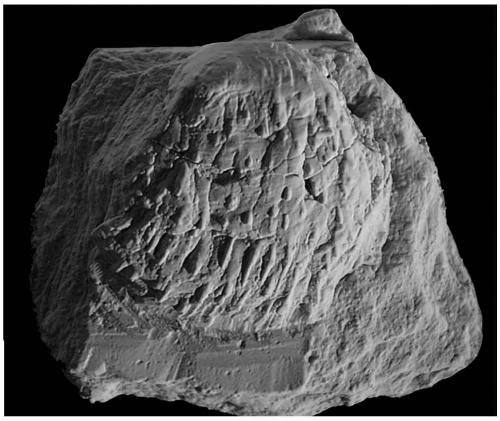
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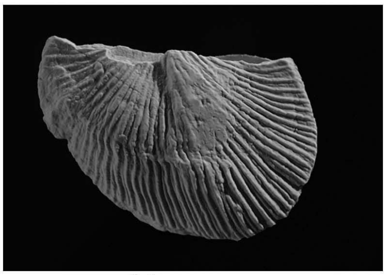
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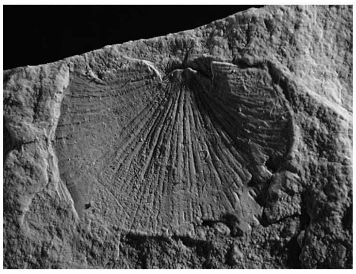
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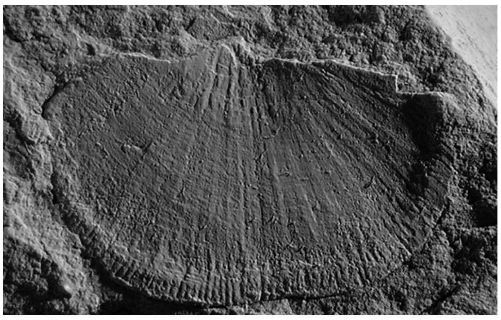
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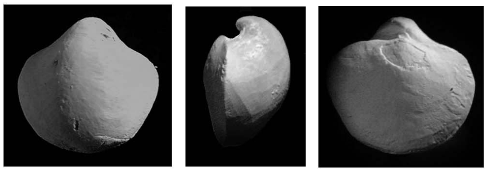
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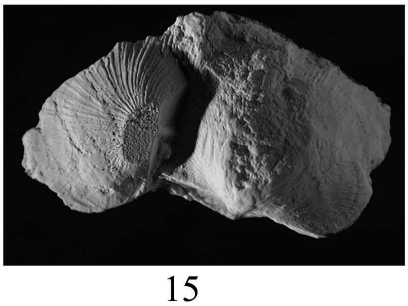
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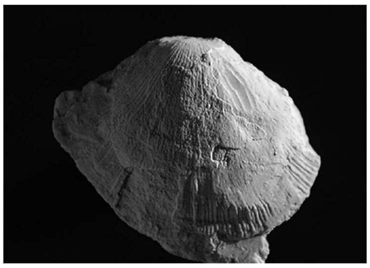
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