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The first find of the Orava Unit in the Púchov section of the Pieniny Klippen Belt (Western Slovakia)

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Abstract

Two klippes of the Orava Unit (Dúbravka and Strapková) have been found at Vršatské Podhradie near Ilava. They are the first occurrences of this unit found in the Púchov section of the Pieniny Klippen Belt. Up to the present time, this unit was known only from Orava territory. A continuous profile of sedimentary succession from the Lower Jurassic to Berriassian has been reconstructed from the newly found klippes. The stratigraphic base of the profile (now in the overturned position) is represented by spotted marly limestones (Allgäu Formation, at least 15 m thick) with Lotharingian ammonoid fauna. They are overlain by greenish-grey marly limestones passing upward to red pseudo-nodular limestones (Kozinec Formation, 3.5 m) containing Upper Lotharingian – Carixian fauna. They are followed by greenish to yellowish marly limestones of Domerian age (up to 2 m thick). The Lower Jurassic part is terminated by strongly condensed red nodular limestone (Adnet Formation, 1–3 m), probably of Toarcian age. The following thick silicitic complex can be divided into lower, spongiolite part (Podzamcze Formation, Aalenian-?Lower Oxfordian, 12.5 m) and upper, radiolarite part (Czajakowa Radiolarite Formation, deleatur), with some nodular, calciturbiditic and micritic limestone layers at its base. The radiolarites are 12 m thick and their stratigraphic range is Middle Oxfordian-Lowermost Kimmeridgian. The silicites are again overlain by red nodular limestones (Czorsztyn Formation, 12–14 m) of Kimmeridgian-Middle Tithonian age. The stratigraphic top of the succession is represented by 45–50 m thick white micritic Calpionella limestone with cherts (Pieniny Formation, Upper Tithonian-Berriassian). The latter formation is in an unique development, containing numerous contourites (commonly silicified), which is atypical for this stratigraphic level in the Pieninic units.

Key words: Jurassic, Western Carpathians, Pieniny Klippen Belt, Orava Unit, stratigraphy, ammonoids

Introduction

The Pieniny Klippen Belt represents the most complicated tectonic structure of the Western Carpathians. This narrow zone, affected by at least two compressional and/or transpressional tectonic events, comprises tectonic lenses and slices of various units that might be originally very distant one to another. Their ongoing reconstruction, lasting even for a century, brings more and more new data. One of them is also a new discovery of the Orava Unit klippes near Vršatec (middle Váh Valley).

The Orava Unit was first time described by Haško (1978), who connected under this name three klippes – Havranský vrch, Červený Kameň near Podbiel and Orava Castle Klippe – considered till then to belong to the Kysuca, Pieniny or Pruské (Niedzica) units (Andrusov, 1931, 1938; Scheibner, 1967). He noted the differences from the Kysuca and Pieniny units, as the aforementioned klippes contain neither flyschoid nor clayey Aalenian sediments but, instead, their Aalenian part is represented by silicites. On the other hand, the lower one from the two horizons of red nodular limestones, that evoke some similarity with the Pruské (Niedzica) Unit, is of different age (Toarcian). As a new transitional unit, Haško (1978) situated the original sedimentary area of the Orava Unit between the Czorsztyn and Kysuca units.

The Orava Unit was until recently found only in the Orava territory. During the detailed mapping in the years 1996–1997, a few new klippes were found that can be attributed to this unit. Klippen Dúbravka (628 m elevation point), Strapková and a nameless small klippe south of Dúbravka are situated a few hundreds of meters NE from Vršatské Podhradie village near Ilava (Fig. 1), close to the well-known klippes Vršatec (Czorsztyn Unit) and Chotúč (Drietoma Unit). The first two klippes are in an overturned stratigraphic position; the most complete succession is preserved at the southwestern portion of the Strapková Klippe. They are both affected by young fault tectonics that caused secondary absence of the Domerian and Toarcian strata at the Strapková Klippe. They are, however, preserved at the neighbouring Dúbravka Klippe. A detailed stratigraphic, paleontologic and sedimentologic investigation of several stacked profiles resulted in construction of a continuous profile from Lotharingian (Upper Sinemurian) to the uppermost Berriassian (Fig. 2). The mentioned klippes were treated only in unpublished manuscripts (Salaj and Began, 1983; Began et al., 1993), where they are considered to belong to the Drietoma Unit.

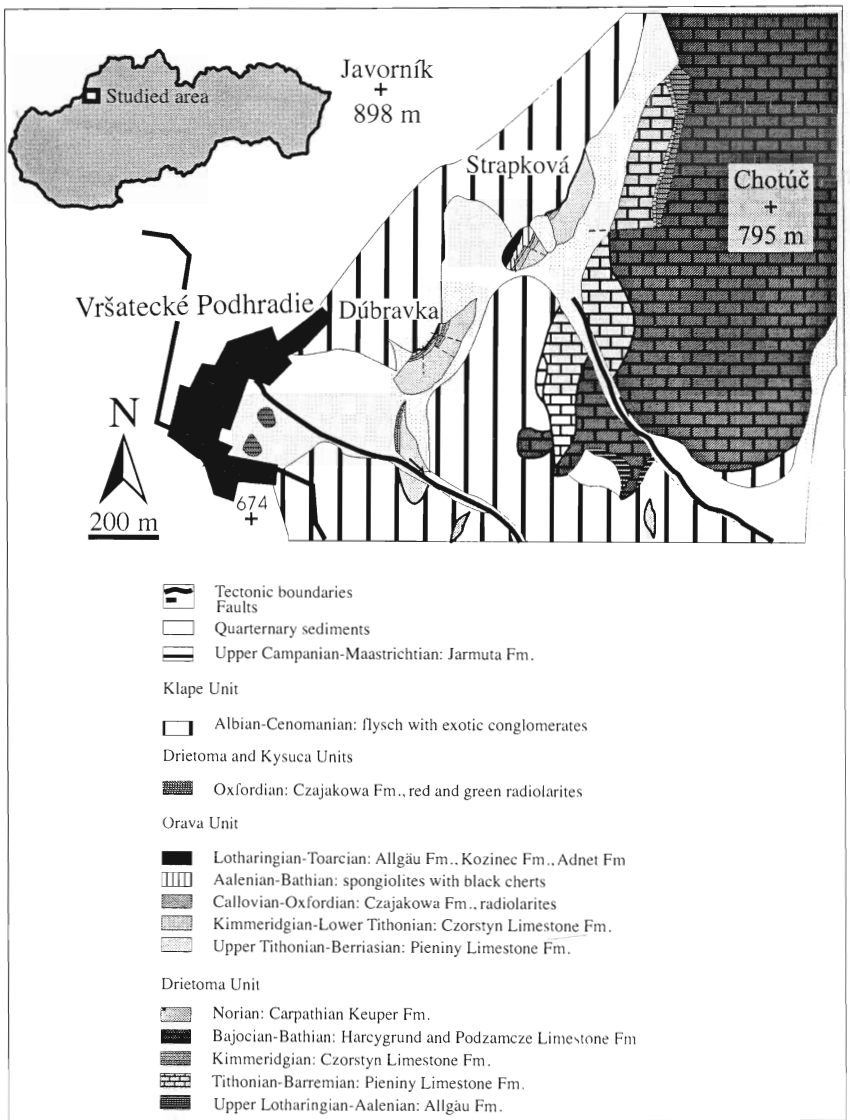


Fig. 1. Position and geological setting of the examined klippes.

Stratigraphy and lithology of the studied profile

The oldest preserved levels of the profile represent thin-bedded (beds up to 8 cm), spotted, marly, micritic limestones to marlstones (Allgäu Formation). They pass upward to greenish, less marly, medium-bedded (10–14 cm), vaguely spotted limestones, containing a rich ammonoid fauna with *Paltechioceras raricostatum quenstedti* (Böse) (Fig. 3) and *Echioceras raricostatum* (Zieten) (Pl. I., Fig. 5). These species indicate the Lotharingian age of the formation. The overall formation thickness could not be verified as the rocks occur just as debris on NW slope of the klippe. The estimated thickness of the formation is at least 15 m.

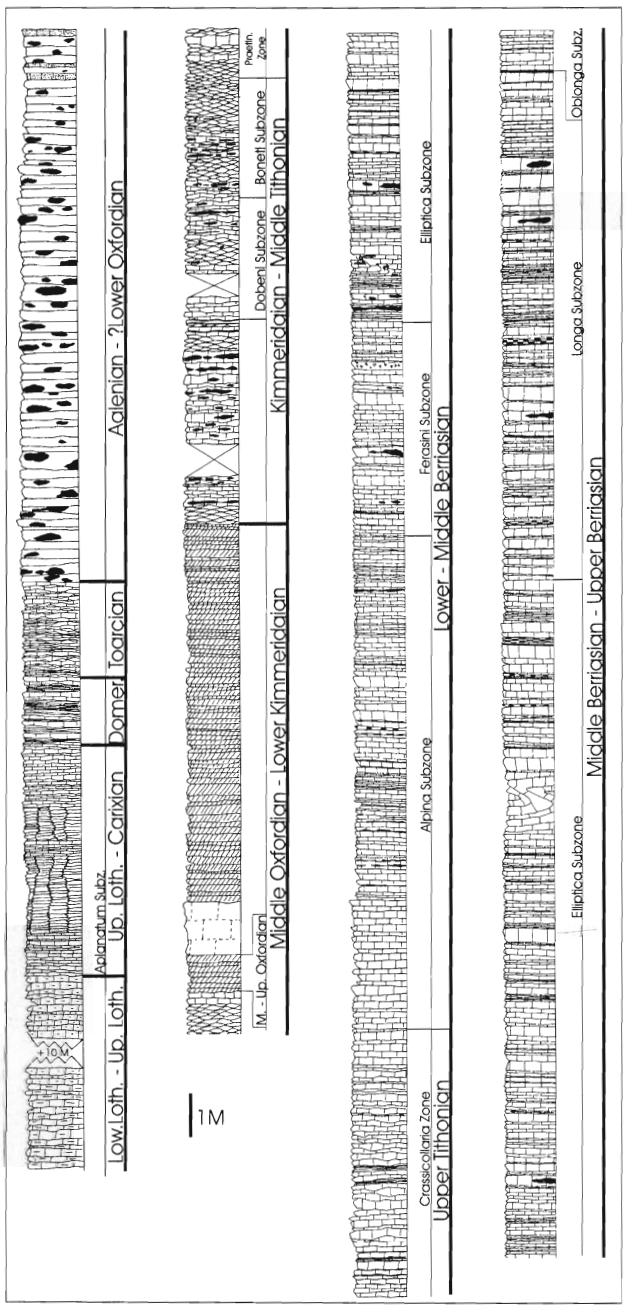
Following greenish to grey-greenish, slightly marly, micritic limestones pass upward to red pseudo-nodular limestones. The limestones are medium-bedded, with beds up to 12 cm thick. Their lithostratigraphic name is Kozinec Formation, after the Kozinec Hill near Zázrivá (Haško, 1975, 1977). The limestones contain ammonoid, brachiopod, bivalve and belemnite fauna, from which the following taxa have been determined: ammonoids – *Prodactylioceras davoei* (Sowerby) (Pl. I., Fig. 6), *Androgynoceras* ex gr. *capricornum* (Schlotheim) (Pl. I., Fig. 4), *Eoderoceras tardecrescens* (Pia) (Pl. I., Fig. 7, 8), *Paltechioceras nodotianum* (d'Orbigny) (Pl. I., Fig. 1), *Paltechioceras ?tardecrescens* (Hauer) (Pl. I., Fig. 2), brachiopods – *Cirpa* sp., *Cirpa langi* Ager, *Spiriferina alpina* Oppel, *Prionorhynchia* cf. *flabellum* (Gemmellaro), *Prionorhynchia serrata* (Sowerby), *Linguithyris curviconcha* Oppel and bivalves – *Oxytoma sinemuriensis* (d'Orbigny) (Fig. 4). The ammonoids indicate the Upper Lotharingian (Aplanatum Subzone) – Carixian age. The overal thickness of the formation is 3.5 m.

The previous formation is overlain by greenish to yellow-greenish, thin bedded marly limestones to marlstones, with bed thicknesses up to 10 cm (average 5 cm). They represent biomicrites with slight admixture of silt and organic detritus, e.g. echinoderm plates, brachiopods, ostracods, *Globochaete alpina* Lombard, thin-shelled bivalves (filaments), agglutinated and nodosariid foraminifers and phosphatic fossil detritus. The limestones also contain a rich ammonoid fauna with *Pleuroceras* ex gr. *hawskerense* (Young and Bird) (Pl. I., Fig. 3), *Protogrammoceras* ex gr. *isslei* (Fucini) (Pl. I., Fig. 11), *Protogrammoceras* ex gr. *nitescens* (Young and Bird) (Pl.I., Fig.10), *Protogrammoceras* ex gr. *celebratum* (Fucini) (Pl. I., Fig. 9), indicating the Domerian age. The thickness of the formation is 1.2–2 m. It can be stratigraphically correlated with the spotted siliceous limestones of Haško (1977, 1978).

The top of the Lower Jurassic part of the succession is represented by strongly condensed red nodular limestones (Adnet Formation, probably Toarcian), with light-red nodules and darker matrix (Fig. 5). The limestones contain numerous, but predominantly fragmental and indeterminable interior casts of ammonoids. Thickness of the formation is 1–3 m.

The Lower Jurassic limestones are followed by thick siliceous complex, in which a lower (spongiolite) and upper (radiolarite) formations can be distinguished.

The spongiolites (Podzamcze Formation) are medium-bedded (beds up to 30 cm thick), very hard, greenish to



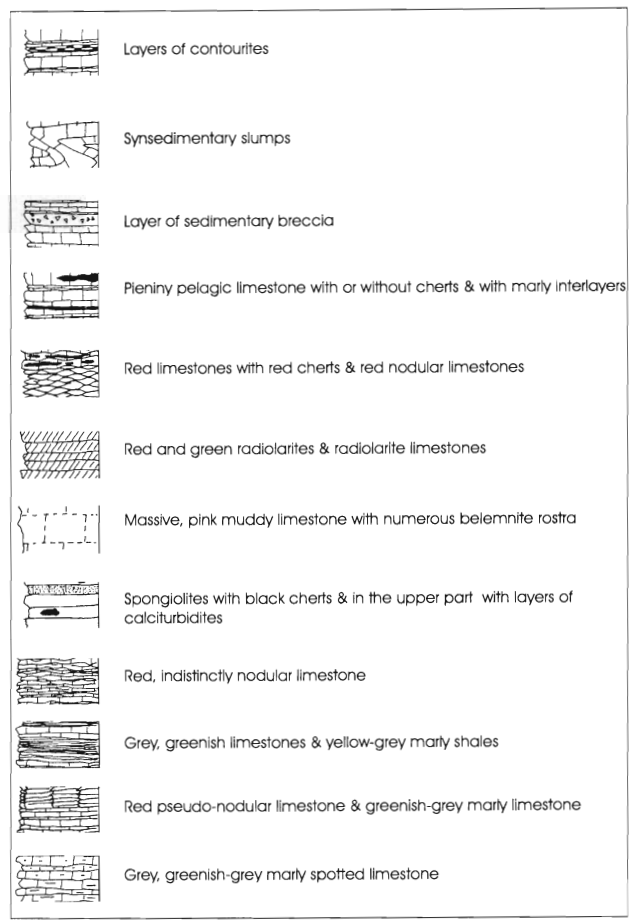


Fig. 2. Profile through the examined klippes of Orava Unit.

grey siliceous limestones, commonly with black cherts. The silica came predominantly from skeletons of siliceous sponges. In the upper part, a few layers of grey crinoidal calciturbidites occur. However, neither the spongiolites, nor the calciturbidites yielded any determinable macrofauna. Based just on superposition, they are ranked to Aalenian-?Lower Oxfordian. The measured thickness of the formation is 12.5 m.

The radiolarites (Czajakowa Formation) are medium-bedded (beds up to 16 cm) siliceous limestones to pure silicites, nearly free of any clayey intercalations. The lower part of the formation is represented by greenish radiolarites (Podmajerz Member) that pass continuously to overlying red radiolarites (Buwald Member). The latter then gradually transit to overlying nodular limestones. The lower red radiolarites (Kamionka Member) defined by Birkenmajer (1977), are usually absent in this unit (Haško, 1978). At our profiles, only relatively thin red radiolarite intercalation occurs at the base, between the limestone layers (see below). The radiolarian limestones represent biomicrites with radiolarian microfacies. Originally increased clay content resulted in deformation of radiolarian tests. The tests are of both, spumellarian and nasellarian types. Most of them are partially or completely calcified. In those still filled by chalcedony (microquartz), common epigenetic calcite rhombs occur (Mišík, 1993). Numerous

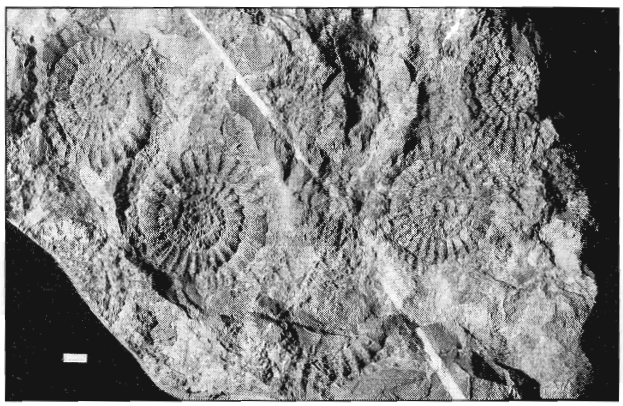


Fig. 3. Several specimens of *Paltechioceras raricostatum quenstedti* (Böse) in grey, slightly spotted limestone, Allgäu Formation, Strapková Klippe, Lotharingian. Scale = 1 cm.

remnants of *Saccocoma* in the uppermost part of the radiolarites indicate Lower Kimmeridgian age.

At the lower boundary of the radiolarites, a 0.4 m layer of calciturbidite and a 1.2 m thick layer of pink to red micritic limestone are present, separated by red radiolarites (0.8 m). Below the lower limestone bed (crinoidal calciturbidite), about 0.8 m thick layer of nodular limestone occurs at the boundary with the underlying spongiolites. The upper, micritic limestone bed is formed by biopelmicrite to biomicrosparite. Numerous peloids may partially represent micritized radiolarian tests (namely the bigger, round-shaped cross-sections). Relics of etched and a few recrystallized echinoderm plates, along with ostracods, juvenile ammonoids, *Globochaete alpina* Lombard, aptychi, foraminifers *Involutina* sp. and detritus of bivalve shells and nodosariid foraminifers are common in the limestone. The upper layer is also rich in belemnite rostra. The limestone interlayers contain slight silty quarz admixture and numerous authigenic feldspars. Dissolving (HF) of sample from the red radiolarite separating these two limestone beds yielded following radiolarian fauna (Pl. II): *Archaeospongoprunum imlayi* Pessagno, *Crucella* cf. *theocaftensis* Baumgartner, *Emiluvia ordinaria* Ožvoldová, *Homeoparonaella* cf. *elegans* (Pessagno), *Hsuum* cf. *brevicostatum* Ožvoldová, *Paronaella mulleri* Pessagno, *Paronaella pygmaea* Baumgartner, *Podobursa spinosa* (Ožvoldová), *Zhamoidellum ovum* Dumitrica, *Tetratrabs zealis* (Ožvoldová), *Transhsuum maxvelli* Pessagno, *Triactoma blakei* (Pessagno), *Triactoma jonesi* (Pessagno), *Tricolocapsa* sp. B, sensu Ožvoldová (1988), *Tritrabs exotica* (Pessagno) and *Tritrabs rhododactylus* Baumgartner. The fauna indicates the Middle Oxfordian age. Dissolving of other radiolarite samples was unsuccessful or yielded very poorly preserved fauna, which is consistent with a former experience in this unit, where most of the radiolarians are very poorly preserved (our observations and Ožvoldová – pers. com.). The proposed age of the formation is Middle Oxfordian to Lower Kimmeridgian.

Czorsztyn Limestone Formation represents red nodular to bedded limestones, evolving gradually from the underlying red radiolarites. In the lower part, the limestones still contain chert nodules and beds in red thin-bedded limestones with undulated bedding planes and intercalations of red shales. The limestone colour varies from pink to reddish-brown. Typical nodular character of the limestone is developed mainly in the upper part of the formation (nodule size is up to 8 cm). The limestones are fine- to medium-grained (increased content of crinoidal detritus). Microscopically, they represent biomicrites (wackestones to packstones), with Saccocoma and Saccocoma-filamentous microfacies. Organic detritus is further represented by echinoderm plates, calcispherulids *Cadosina fusca fusca* Wanner, *Colomisphaera fibrata* (Nagy), *Schizosphaerella minutissima* (Vogler), and other organisms, like *Globochaete alpina* Lombard, ostracods, thin-shelled bivalves and aptychi. The upper part of the Czorsztyn Limestone Formation contains rich assemblage with calpionellids *Chitinoidella dobeni* Borza and *Chitinoidella boneti* Doben, representing two individual subzones in the upper part of the Middle Tithonian. The beds transitional to the overlying Pieniny Limestone Formation contain *Praetintinopsella andrusovi* Borza, forming a separate range zone in the lower part of Late Tithonian (sensu Reháková and Michalík, 1997). The microfacies and micropaleontologic study display the Kimmeridgian-Middle Tithonian age (Boneti Subzone in the calpionellid time scale) of the formation. Its entire thickness is 12–14 m.

Pieniny Limestone Formation represents pale calpionellid limestones, evolving gradually from the underlying Czorsztyn Formation. At the base, the limestones are slightly greenish, upward they are white to light-grey, with numerous cherts. They are biomicrites with calpionellid microfacies and common stylolites. They contain many *Crassicollaria parvula* Remane, *Calpionella alpina* Lorenz, *Calpionella elliptica* Cadisch, *Tintinnopsella carpathica* (Murgeanu et Filipescu), *Tintinnopsella longa* (Colom), *Remaniella ferasini* (Catalano), *Remaniella borzai* Pop, *Remaniella duranddelgai* Pop, *Remaniella*

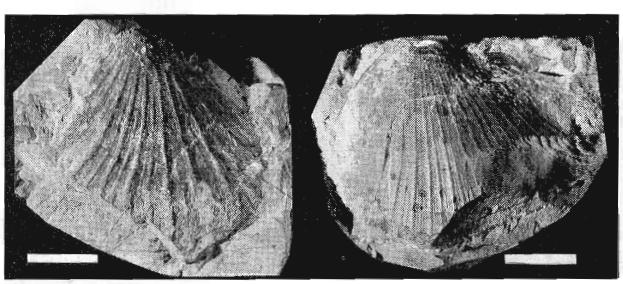


Fig. 4. *Oxytoma sinemuriensis* (d'Orbigny) – two right valves, Strapková Klippe, Kozinec Fm. Scale = 1 cm.

Fig. 5. Red, indistinctly nodular limestone with cross-section of partly dissolved ammonoid shell, Adnet Formation, probably of Toarcian age. Scale = 1 cm.

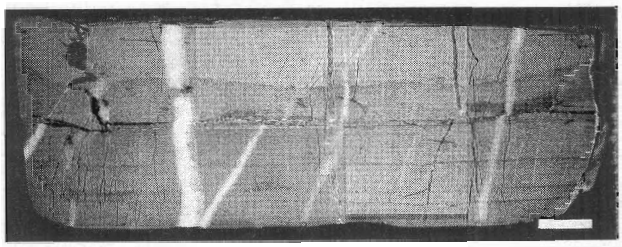


Fig. 6. Polished cross-section of fine-laminated contourite. Each lamina consists of well-sorted, normaly graded radiolarite biomicrite created by bottom currents, Berriassian, Pieniny Limestone Formation. Scale = 1 cm.

cadischiana (Colom), *Remaniella catalanoi* Pop, *Remaniella filipescui* Pop, *Calpionellopsis oblonga* (Cadisch), ?*Calpionellopsis simplex* (Colom), calcified radiolarians, *Globochaete alpina* Lombard, calcispherulids *Schizosphaerella minutissima* (Vogler), *Cadosina fusca fusca* Wanner, and echinoderm plates. Less common are ostracods, foraminifers *Patellina* sp., *Lenticulina* sp., *Spirillina* sp. and various uniserial forms, ophiurian calcite segments, filaments (thin-shelled bivalves), aptychi and calcified spicules. The stacked profiles of the Strapková Klippe show stratigraphic range of the formation from the aforementioned Andrusovi Zone up to the lowermost part of the Oblonga Subzone, i.e. the Uppermost Berriassian. Relatively thick sediments of the Elliptica Subzone are characterized by the presence of numerous commonly silicified contourites (Fig. 6), a few synsedimentary slump folds, disturbing continuity of the profiles, and one layer of sedimentary breccia. The slump folds contain also deformed cherts, documenting a rock deformation still in plastic stage. The whole Berriassian part of the profile is unique; up to date, such miscellaneous deep-water development was not known from any of the Pieninic units of the Pieniny Klippen Belt. The slump and resedimentation structures suggest deposition on a slightly inclined bottom. The contourites represent fine-grained sediments transported and deposited by bottom currents. Machhour et al. (1994) localize the classic contour currents to continental slope foot. Directions of these currents more or less follow the shelf margin. The contourites at the Strapková profile are well sorted, finely laminated sediments with radiolarian microfacies. Round-shaped to short conical forms prevail (99 %) whereas spiny and elongated types are subordinate or lack completely. Most of them were probably rounded by transport which is, however, indistinguishable in thin sections due to complete calcitization of the tests. The radiolarian tests are arranged to normally graded laminae. Content of calpionellids is up to 5 %, benthos vary in the range of 0–2.5 %, silty admixture (probably of aeolian origin) is commonly less than 0.5 % The fine lamination of the contourites indicates their polyphase origin. Each lamina represents an individual record after one contour current. The thickness of such lamina is about a few tenths of mm to 5 mm. The individual currents had to follow relatively shortly after each other since no calcareous intercalations deposited among the siliceous laminae. The entire thickness of the contourites ranges between 1 to 8 cm. Quantitative and qualitative evaluation of the thin sections from the whole Berriassian part (time oscillations of the individual components, e.g. calpionellids, radiolarians, benthos, silt, etc., were evaluated) some conclusions on sequence stratigraphy were achieved (Schlögl and Michalík, in prep.). Prolific periods of calpionellids were related to sea-level lowstands (they indicate lowstand systems tracts in the pelagic environment); on the contrary, radiolarians are known to shun the daylight and migrate every day into deeper parts of the sea and return in the night. Therefore, their maximum extent is related to sea-level highstands (they indicate highstand systems tracts). In the Berriassian, maximum vertical difference about 10–30 m between the highstand and lowstand levels is supposed (Sahagian et al., 1996). Other allochems, occurring in little amounts, play just a subordinate role in the sequence stratigraphic evaluation. The preserved thickness of the Pieniny Limestone Formation, deduced from three stacked profiles, is at least 45–50 m.

Systematic paleontology of the molluscan fauna

class **Cephalopoda** Leach, 1817
order Ammonoidea Zittel, 1884
suborder Ammonitina Hyatt, 1889
superfam. Psiloceratacеae Hyatt, 1867
fam. *Arietitidae* Hyatt, 1874, sensu Schindewolf, 1962
subfam. *Echioceratinae* Buckman, 1913
gen. *Paltechioceras* Buckman, 1924
Paltechioceras nodotianum (d'Orbigny, 1842),
Pl. I., Fig. 1

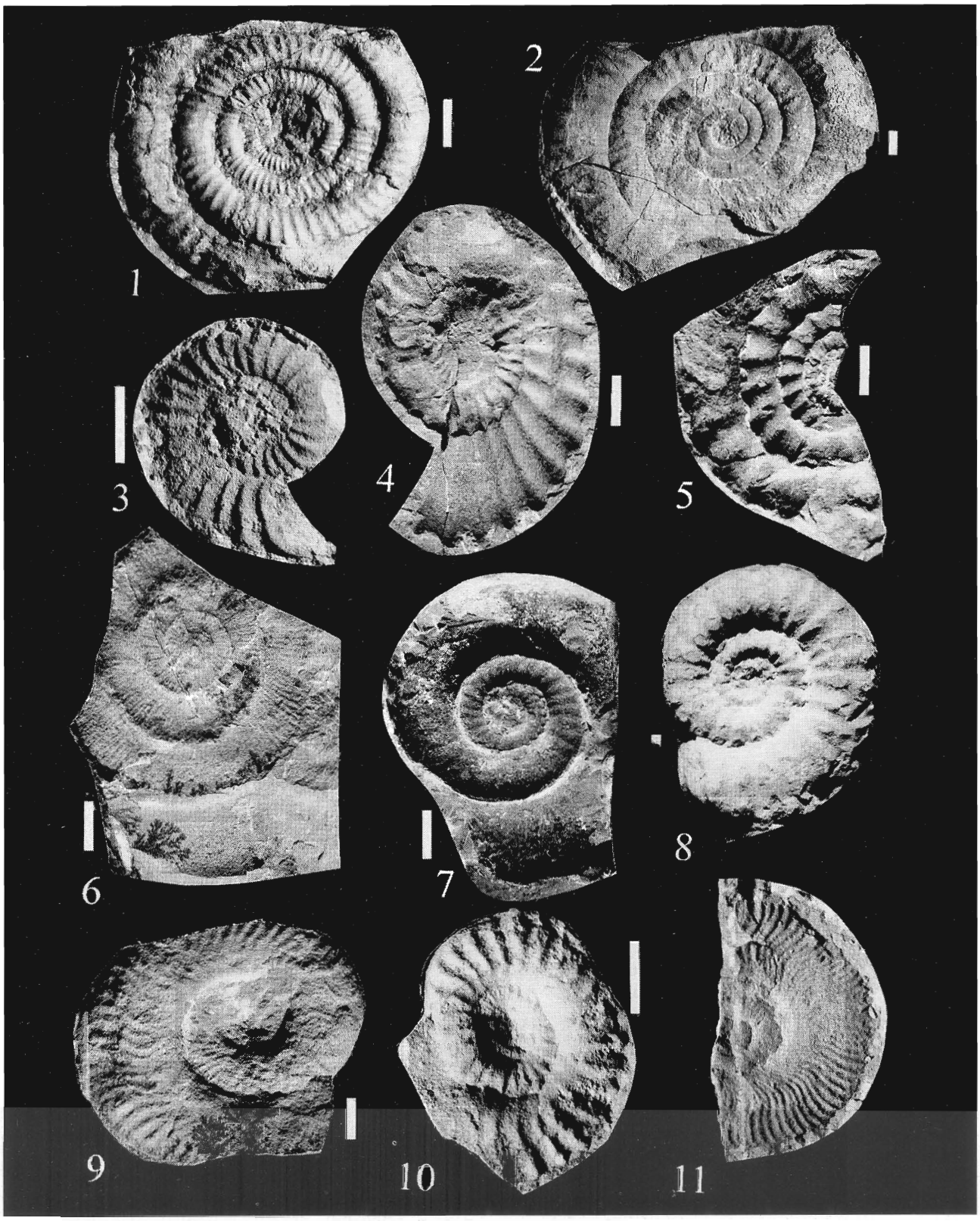
Material: One almost complete, slightly deformed specimen in marly limestone (Kozinec Member).
Dimensions: D- 7.0 Wh- 1.32 Wb- x O- 4.46
Description: Serpenticone evolute form, whorl sides vaulted with pronounced, high density ribbing. Ribs slightly prorsiradiate. Ventral side not visible. Suture line not preserved.
Stratigraphic range: Upper Lotharingian, Aplanatum Subzone.

Paltechioceras* cf. *tardecrescens (Hauer, 1856),
Pl. I., Fig. 2

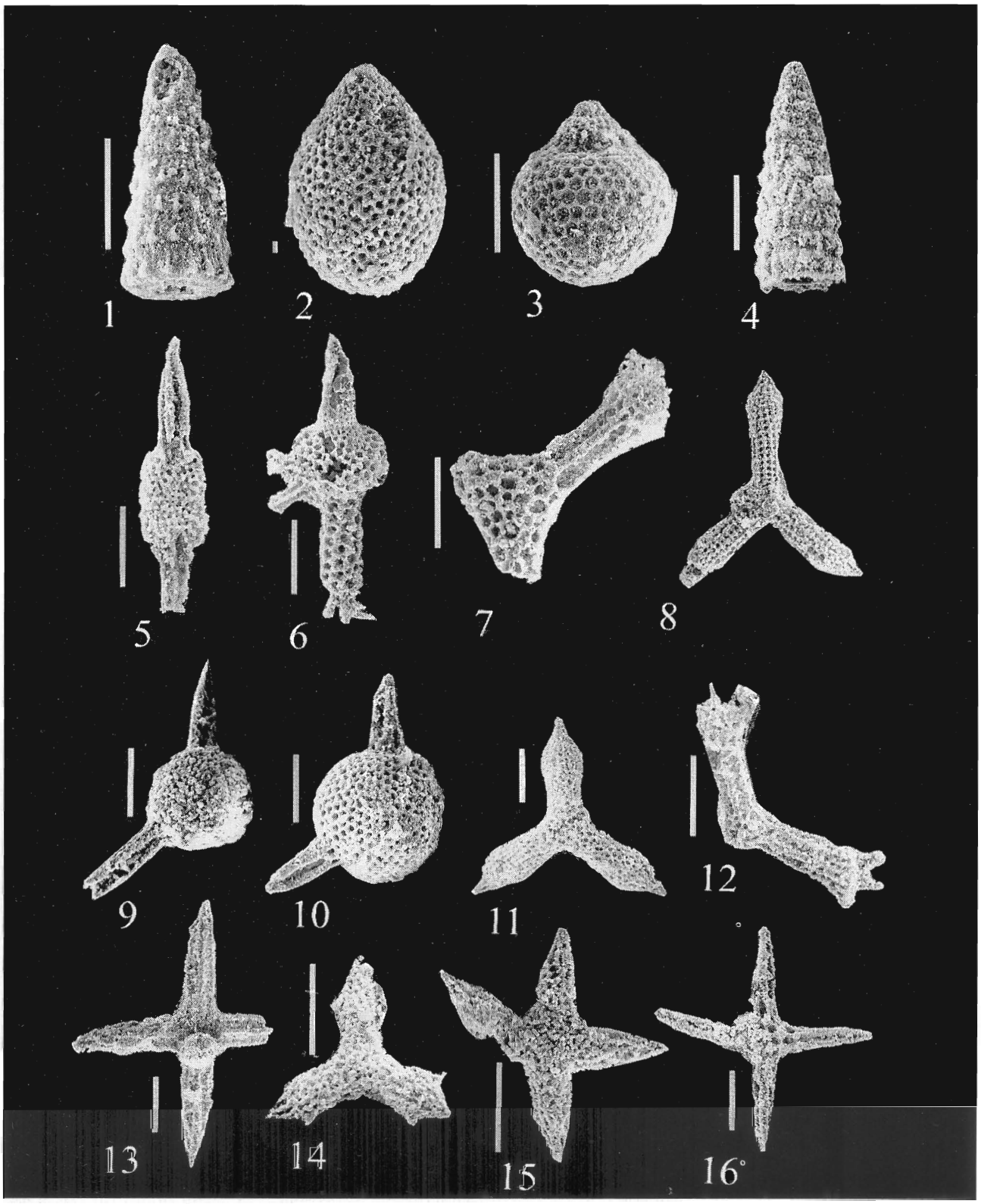
Material: One almost complete specimen in red, pseudonodular limestone (Kozinec Member)
Dimensions: D- 151.0 Wh- 30.0 Wb- x O- 96.0
Description: Evolute form with oval cross-section of whorl. Ventrum is bifurcate with pronounced keel. Whorl sides faintly convex with rursiradiate ribs. Suture line not observed.
Stratigraphic range: Upper Lotharingian, Aplanatum Subzone.

Paltechioceras raricostatum quenstedti
(Böse, 1893), Fig. 3

Material: Nine specimens with different state of preservation in grey slightly spotted limestone.



Pl. I. Lower Jurassic ammonoid fauna from the Strapková Klippe. 1 – *Paltechioceras nodotianum* (d'Orbigny), Kozinec Fm., 2 – *Paltechioceras* sp. *?tardecrescens* (Hauer), Kozinec Fm., 3 – *Pleuroceras* gr. *hawskerense* (Young and Bird), Domerian, 4 – *Androgynoceras* gr. *capricornum* (d'Orbigny), Kozinec Fm., 5 – *Echioceras raricostatum* (Zieten), Allgäu Fm., Lotharingian, 6 – *Prodactylioceras davoei* (Sowerby), Kozinec Fm., 7, 8 – *Eoderoceras tardecrescens* (Pia), Kozinec Fm., 9 – *Protogrammoceras* gr *celebratum* (Fucini), Domerian, 10 – *Protogrammoceras* gr. *nitescens* (Young and Bird), Domerian, 11 – *Protogrammoceras* gr. *isslei* (Fucini), Domerian. Uniform scale = 1 cm.



Pl. II. Radiolarian fauna of U. A. 9 (Middle Oxfordian to lower part of Upper Oxfordian) from the Strapková Klippe. 1 – *Transhsuum maxvelli* gr Pessagno, 2 – *Zhamoidellum ovum* Dumitrica, 3 – *Tricolocapsa* sp. B, sensu Ožvoldová (1988), 4 – *Hsuum* cf. *brevicostatum* Ožvoldová, 5 – *Archaeospongoprunum imlayi* Pessagno, 6 – *Podobursa spinosa* (Ožvoldová), 7 – *Tritrabs exotica* (Pessagno), 8 – *Homeoparonaella* cf. *elegans* (Pessagno), 9 – *Triactoma jonesi* (Pessagno), 10 – *Triactoma blakei* (Pessagno), 11 – *Paronaella mulleri* Pessagno, 12 – *Tritrabs rhododactylus* Baumgartner, 13 – *Tetratrabs zealis* (Ožvoldová), 14 – *Paronaella pygmaea* Baumgartner, 15 – *Crucella* cf. *theocaftensis* Baumgartner, 16 – *Emiluvia ordinaria* Ožvoldová. Uniform scale = 1 μm.

Dimensions: D- 63.0 Wh- 12.0 Wb- x O- 42.0
61.0 x x 38.5
56.8 x x 35.0

Description: Serpenticone evolute form, with pronounced radiate ribs, whorl sides convex. Ventral side not visible. Suture line not observed.
Stratigraphic range: Lotharingian, Raricostatum Zone.

Echioceras raricostatum (Zieten, 1831), Pl. I., Fig. 5

Material: One incomplete stone core (approxim. a half of complete specimen), partly compressed in grey-greenish, slightly spotted limestone.
Description: Shell evolute (serpenticone) with ventrally depressed cross-section of whorl. Whorl sides convex with strong, straight and distinct ribs. Space between ribs wide. Ventral side unicarinate. Suture line not observed.
Stratigraphic range: Lotharingian, Raricostatum Zone.

superfam. EODEROCERATACEAE Spath, 1929
fam. *Liparoceratidae* Hyatt, 1867
gen. *Androgynoceras* Hyatt, 1867
Androgynoceras* gr. *capricornum (Schlotheim, 1820), Pl. I., Fig. 4

Material: One complete, but strongly deformed specimen in green-greyish limestone (Kozinec Member)
Description: Evolute form, whorl sides with pronounced radiate ribs. Intercalar space wider than rib width. Suture line not observed.
Stratigraphic range: Carixian, Capricornum Zone.

fam. *Amaltheidae* Hyatt, 1867
gen. *Pleuroceras* Hyatt, 1867
Pleuroceras* gr. *hawskerense (Young and Bird, 1828), Pl. I., Fig. 3

Material: Two almost complete, compressed specimens, one mold of complete undeformed specimen and many fragments in yellow-greyish or grey marly limestone or marlstone.
Dimensions: D- 27.0 Wh- 9.1 Wb- x O- 11.8
31.4 10.0 x 14.0

Description: Evolute form with flattened whorl sides. Ribs strong, slightly rursiradiate, turning apertually in the periventral part and ending in ventrolateral tubercules. Umbilicus wide, shallow. Ventral side with serrated keeled. Suture line not preserved.
Stratigraphic range: Upper Domerian, Hawskerense Subzone

fam. *Dactylioceratidae* Hyatt, 1867,
sensu Krymgolz, 1958
subfam. *Coeloceratinae* Haug, 1910,
sensu Schmidt - Effing, 1972
gen. *Prodactylioceras* Spath, 1923
Prodactylioceras davoei (Sowerby, 1922), Pl. I., Fig. 6

Material: Two incomplete, deformed specimens in greenish limestone (Kozinec Member)
Description: Serpenticone evolute form with faintly prorsiradiate, high density ribbing. Umbilicus large, shallow. Suture line not observed.
Stratigraphic range: Carixian, Davoei Zone

fam. *Eoderoceratidae* Spath, 1929
subfam. *Eoderoceratinae* Spath, 1929
gen. *Eoderoceras* Spath, 1925
Eoderoceras tardecrescens (Pia, 1923),
Pl. I., Fig. 7, 8

Material: One complete core of subadult specimen and one damaged adult stage stone core in green-greyish limestone (Kozinec Member)
Dimensions: D- 35.5 Wh- 12 Wb- 8 O- 17.5
70.0 19 x 34.0

Description: Evolute form with oval cross-section of whorl. Only inner whorls with apparent riblets. Outer whorls almost smooth. Ornamentation consists of rounded, radiate riblets with two lines of small tubercules. Suture line not preserved.
Stratigraphic range: Lotharingian – Lower Carixian, Raricostatum Zone, Jamesoni Zone

superfam. HILDOCERATACEAE Hyatt, 1867
fam. *Hildoceratidae* Hyatt, 1867
subfam. *Arieticeratinae* Howarth, 1955
gen. *Protogrammoceras* Spath, 1913
Protogrammoceras* gr. *isslei (Fucini, 1905),
Pl. I., Fig. 11

Material: One incomplete, compressed stone core (a half of specimen) in yellowish marly limestone.
Description: Convolute form with lanceolate cross-section of whorl. Whorl sides almost flat, only a little convex. Ornamentation in a form of dense falcoid ribs beginning near umbilical margin, falcate toward aperture at ventral margin. Ventral side with minute keel. Umbilicus relatively wide, shallow. Suture line not observed.
Stratigraphical range: Domerian

Protogrammoceras* gr. *nitescens (Young and Bird, 1822),
Pl. I., Fig. 10

Material: Three specimens with different preservation in green-greyish marly limestone
Dimensions: D- 39.2 Wh- 14.0 Wb- 8.0 O- 14.4
51.4 18.0 x 21.0

Description: Convolute form with high oval cross-section of whorl. Ventral side with pronounced keel. Flattened whorl sides with strong radiate ribbing beginning near umbilical margin. Umbilical margin rounded. Umbilicus wide, moderately deep. Suture line not observed.
Stratigraphic range: Domerian

Protogrammoceras* gr. *celebratum (Fucini, 1900), Pl. I., Fig. 9

Material: One almost complete, slightly deformed specimen and four fragments of whorls in yellowish marly limestone. One of fragments is in red marly limestone.
Dimensions: D- x Wh- x Wb- 9.0 O- 31.0
Description: Involute form with lanceolate cross-section of whorl. Ventral side with small keel. Umbilicus relatively wide with rounded umbilical margin Slightly convex whorl sides with ornamentation in form of dense falcoidal ribs beginning at umbilical margin, falcate toward aperture at ventral margin. Suture line not observed.
Stratigraphic range: Early Domerian, Stokesi Subzone.

class **BIVALVIA** Linnaeus, 1758
subclass PTERIOMORPHA Beurlen, 1944
order PTERIOIDA Newell, 1965
superfam. PECTINACEA Rafinesque, 1815
fam. *Oxytomidae* Ichikawa, 1958
gen. *Oxytoma* Meek, 1864
Oxytoma sinemuriensis (d'Orbigny, 1847), Fig. 4

Material: two right valves and several fragments of valves.
Description: Medium-sized, suborbicular to ovate, inequilateral prosocline valves. Left anterior wing is small. Posterior wing is elongated, sharply pointed. The sculpture on left valve consists more or less regularly of narrow radial ribs of 3 orders of strength. There are 14 to 16 coarse primary ribs. The intercostal spaces become gradually broader. Between each two primary ribs there is one median secondary rib. Between secondary and primary rib are sometimes visible one or two tertiary ribs.
Stratigraphic range: Sinemurian – Lotharingian.

Discussion

Though this is the first information of the occurrence of the Orava Unit outside Orava territory, our opinion is that this unit may be more common in the Pieniny Klippen Belt. In many cases, when the Liassic and Aalenian part of this unit is missing, it is assigned to some other similar unit. The klippes described herein were considered to belong to Drietoma Unit (Salaj and Began, 1983; Began et al., 1993).

If compared with the Orava occurrences of the unit (Haško, 1978), these new localities show more condensed (thinner) Liassic formations. Some differences can be seen also in the Lower Cretaceous part. Haško (1977, 1978) provides no clear calpionellid zonation. Nevertheless, it is obvious that the Berriassian part of the Orava Unit is usually much less cherty that at our occurrences.

There is also a problem of the age of the lower nodular limestone in the Orava Unit. Whereas Haško (1977, 1978) and this paper attributed them to the Toarcian, Borza (1989) introduced a new age interpretation of this limestone. According to his opinion, based on microfacial study of the Kozinec Klippe, it reaches Bathonian (Globuligerina microfacies). This was, however, not confirmed by our investigation at the same klippe, where we found just the filamentous microfacies. Nevertheless, this problem is to be dealt in detail in the future, as the proposed long time span of the silicites in this unit (Aalenian-Lower Kimmeridgian) is unusual.

Conclusions

1. Three klippes of the Orava Unit have been found near Vršatec. They represent the first occurrences of this unit outside Orava territory.
2. The time span of the studied profiles is Lower Jurassic (Lotharingian) to Lower Cretaceous (Berriassian).
3. These new occurrences suggest that the Orava Unit may be more common in the Pieniny Klippen Belt but is usually misinterpreted as one of the other basinal units (e. g. Kysuca-Pieniny Unit).
4. There are some differences from the previously described klippes in Orava: more condensed Lower Jurassic sequence and mass presence of cherts and contourites in the Upper Jurassic-Lower Cretaceous part. The latter is unusual for any of the units of the Pieniny Klippen Belt.
5. At the base of the Czajakowa Radiolarite Formation, layers of calciturbidite, nodular limestone and pink micritic limestone occur, representing a break in the sedimentation of silicites.
6. The slump structures and contourites in the Lower Cretaceous deposits document sedimentation on a slope/foot transitional area.

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Prvý nález oravskej jednotky v púchovskom úseku pieninského bradlového pásma

Pri Vršatskom Podhradí neďaleko Ilavy sa našli dve bradlá oravskej jednotky – Dúbravka a Strapková. Ide o prvé výskyty tejto jednotky v púchovskom úseku bradlového pásma, predtým známej iba z Oravy. V bradlách možno sledovať takmer súvislý profil od liasu do beriasu. Spodnú časť profilu (v prevrátenej vrstvovej pozícii) tvorí súvrstvie škvrnitého slienitého vápenca (algäuské súvrstvie) s overenou hrúbkou najmenej 15 m obsahujúceho amonitovú faunu lotaringu s *Paltechioceras raricostatum quenstedti* (Böse), *Echioceras raricostatum* (Zieten) a s lastúrnikom *Oxytoma sinemuriensis* (d'Orbigny). Nad týmto súvrstvím je zelenkavosivý slienitý vápenec, ktorý vyššie prechádza do červeného pseudohľuznatého vápenca s faunou karixu. Fauna obsahuje amonity *Prodactylioceras davoei* (Sowerby), *Androgynoceras* ex gr. *capricornum* (Schlotheim), *Eoderoceras tardecrescens* (Pia), *Paltechioceras nodotianum* (d'Orbigny), *Paltechioceras ?tardecrescens* (Hauer) a brachiopódy *Cirpa* sp., *Cirpa langi* Ager, *Spiriferina alpina* Oppel, *Prionorhynchia* cf. *flabellum* (Gemmellaro), *Prionorhynchia serrata* (Sowerby), *Linguithyris curviconcha* Oppel. Toto 3,5 m hrubé súvrstvie možno korelovať s kozinskými vrstvami (Haško, 1975, 1977). Nad ním sú vrstvy zelenkastého až žltkastého slienitého vápenca domérskeho veku hrubé 2 m. Obsahujú faunu amonitov *Pleuroceras* ex gr. *hawskerense* (Young a Bird), *Protogrammoceras* ex gr. *isslei* (Fucini), *Protogrammoceras* ex gr. *nitescens* (Young a Bird) a *Protogrammoceras* ex gr. *celebratum* (Fucini). Liasovú časť zakončuje silne kondenzovaný červený hľuznatý vápenec pravdepodobne toarského veku (adnetské súvrstvie) v hrúbke 1 až 3 m. Ďalej nasleduje hrubý komplex silicitov, ktorý možno rozdeliť na spodnejšiu spongolitovú časť hrubú 12,5 m (podzamczianske súvrstvie, álen–?spodný oxford) a vrchnejšiu, rádiolaritovú časť s hrúbkou 12 m (czajakovské súvrstvie, stredný oxford–spodný kimeridž). Na báze rádiolaritovej časti sa vyskytujú polohy vápenca v podobe hľuznatého vápenca, krinoidového kalciturbiditu a hrubšej lavice ružového mikritického vápenca (pelmikrit). Z celého silicitového komplexu sa podarilo presnejšie stratigraficky zaradiť len jednu vzorku rádiolaritu, ktorá pochádza spomedzi spomenutých vrstiev vápenca. Vzorka obsahuje faunu rádiolárií *Archaeospongoprunum imlayi* Pessagno, *Crucella* cf. *theocaftensis* Baumgartner, *Emiluvia ordinaria* Ožvoldová, *Homeoparonaella* cf. *elegans* (Pessagno), *Hsuum* cf. *brevicostatum* Ožvoldová, *Paronaella mulleri* Pessagno, *Paronaella pygmaea* Baumgartner, *Podobursa spinosa* (Ožvoldová), *Zhamoidellum ovum* Dumitriça, *Tetratrabs zealis* (Ožvoldová), *Transhsuum maxvelli* Pessagno, *Triactoma blakei* (Pessagno), *Triactoma jonesi* (Pessagno), *Tricolocapsa* sp. B, sensu Ožvoldová (1988), *Tritrabs exotica* (Pessagno) a *Tritrabs rhododactylus* Baumgartner. Fauna patrí do jednotkovej asociácie U. A. 9, poukazujúcej na stredný oxford až spodnú časť vrchného oxfordu. Po silicitovom komplexe nasleduje súvrstvie vrchného červeného hľuznatého vápenca (czorsztynský vápenec) hrubé 12 až 14 m. Podľa prítomnosti sakokóm, kalcisferulíd *Cadosina fusca fusca* Wanner, *Colomisphaera fibrata* (Nagy), *Schizosphaerella minutissima* (Vogler) a kalpionelíd *Chitinoidella dobeni* Borza a *Chitinoidella boneti* Doben, vyskytujúcich sa vo vrchnej časti súvrstvia, je súvrstvie kimeridžského až strednotitónskeho veku. Prechodná časť medzi vrstvou czorsztynského a nadložného pieninského vápenca obsahuje *Praetintinopsella andrusovi* Borza, čo poukazuje na najspodnejšiu časť vrchného titónu. Celú sukcesiu zakončuje biely mikritický rohovcový vápenec (pieninský vápenec) v hrúbke 45–50 m a vo vekovom rozpätí vrchný titón až berias. Súvrstvie obsahuje bohatú faunu kalpionelíd s *Crassicollaria parvula* Remane, *Calpionella alpina* Lorenz, *Calpionella elliptica* Cadisch, *Tintinnopsella carpathica* (Murgeanu et Filipescu), *Tintinnopsella longa* (Colom), *Remaniella ferasini* (Catalano), *Remaniella borzai* Pop, *Remaniella duranddelgai* Pop, *Remaniella cadischiana* (Colom), *Remaniella catalanoi* Pop, *Remaniella filipescui* Pop, *Calpionellopsis oblonga* (Cadisch), *? Calpionellopsis simplex* (Colom), ako aj kalcisferulidy *Schizosphaerella minutissima* (Vogler) a *Cadosina fusca fusca* Wanner. Toto súvrstvie je vyvinuté netypicky, pretože obsahuje mnohé konturity (často silicifikované), sklzové štruktúry a polohu synsedimentárnej brekcie, ktoré svedčia o sedimentácii na úpätí až miernom svahu.