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Upper Palaeozoic Fossils from Clastic Sedimentary Rocks in the Gorski Kotar Region

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Key words: Upper Palaeozoic, Fossils, Gorski Kotar, Croatia.

Ključne riječi: gornji paleozoik, fosili, Gorski kotar, Hrvatska.

Abstract

Clastic sedimentary rocks in the vicinity of Mrzle Vodice in the Gorski kotar region contain numerous Upper Palaeozoic fossils, preserved as skeletal detritus in calclithites, or within lithoclasts in coarse-grained sediments. Seventy-two taxa have been determined (most of them for the first time) in this region. The most abundant groups are foraminifers and calcareous algae. Calcisponges, echinoderms and bryozoans occur frequently, while remnants of molluscs, brachiopods and ostracods are scarce. The determined taxa range from the Lower Carboniferous (Viséan), through the Upper Carboniferous (Moscovian, Kasimovian, Gzhelian), up to the Lower Permian (Asselian) in age. Some of the clastic sediments show traces of the multiple redeposition.

Sažetak

Klastični sedimenti okolice Mrzlih Vodica u Gorskome kotaru sadrže brojne gornjopaleozojske fosile, koji predstavljaju skeletni detritus u kalklititima, ili su pak unutar litoklasta u krupnozrnatim sedimentima. Određena su sedamdesetdva taksona, među kojima je većina po prvi puta nađena u ovom području. Najčešći su nalazi foraminifera i algi, zatim kalcispongija, bodljikaša i briozoa, dok se nešto rjeđe nađu mekušci, ramenonošci i ostrakodi. Među nađenim su vrstama i provodni fosili donjega karbona (vizé), gornjega karbona (moskovij, kasimovij, gželij) i donjega perma (aselij). Neki fosili pokazuju tragove višestrukog pretaloživanja.

1. INTRODUCTION

At several localities in the vicinity of Mrzla Vodica in the Gorski Kotar region (Kosmačev Brijeg hill and creeks: Križ potok, Mrzlica potok and Jezerine potok) clastic sediments have been sampled for sedimentological and palaeontological analysis (Fig. 1). The thickness of the clastic complex has been estimated at approximately 150 m. At the exposed outcrops, heterogenous sediments occur: from black shales and various sandstones (including the peculiar calclithites) to orthoquartzite and petromict conglomerates and calcareous breccias. These sediments alternate laterally and vertically, and some of the varieties repeatedly appear in the vertical section (ALJINOVIĆ et al., 1997). Unfortunately, in these wild forests, Permian outcrops are not well exposed, and the complete succession cannot be observed.

2. PREVIOUS STUDIES OF PALAEOZOIC FOSSILS IN THE GORSKI KOTAR

Upper Palaeozoic fossils, predominantly fusulinids and ammonoids, from Gorski Kotar were studied for the first time by the Austrian geologists SCHUBERT (1907) and VOGL (1913).

Croatian geologists under the leadership of M. Salopek prepared the detailed geological maps of this area (SALOPEK, 1949, 1960). Carboniferous "fusulinid" (*Triticites*) sandstones and heterogeneous Permian sediments, ranging from the Rattendorf to the Sosiostage, have been distinguished in the vicinity of Mrzla Vodica (Fig. 1). Salopek considered the Upper Permian Bellerophon beds to be absent in this region. Fusulinids, brachiopods and goniatite ammonoids were collected during these investigations. Unfortunately, some parts of the area have been flooded during the construc-

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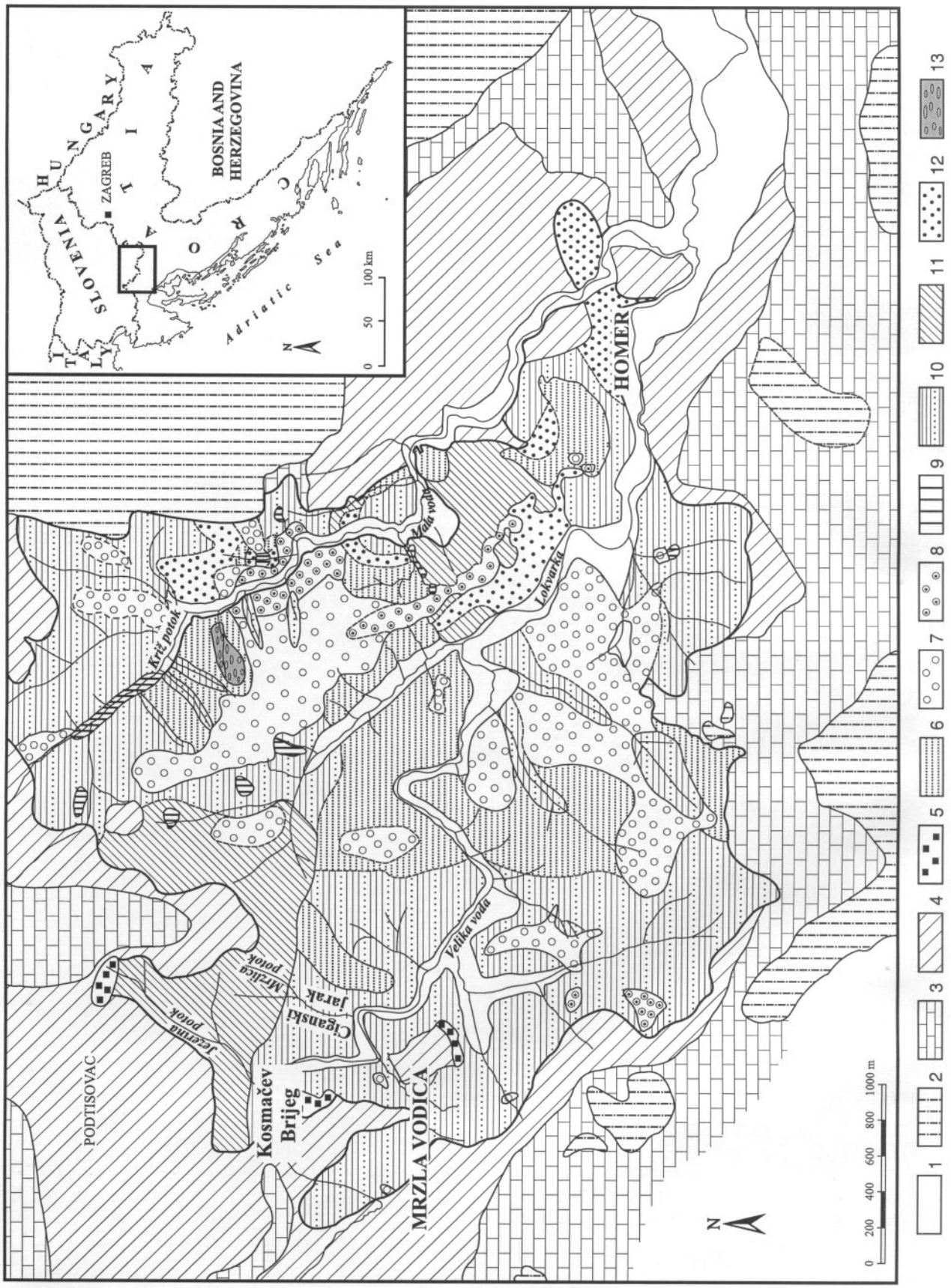

Fig. 1 Geological map of the area surrounding Mrzla Vodica (after SALOPEK, 1960, partly modified). Legend: 1) Q - alluvial deposits; 2) J_1 - limestone; 3) T_3 - dolomite; 4) T_1 - clastic sediments and dolomites; 5) P/T - barite, pyrite and limonite deposits; 6) P - sandstones; 7) P - quartz-conglomerates; 8) P - porous conglomerates; 9) P - massive dark-coloured limestones; 10) P - black shales and sandstones in alternation; 11) P - black shales; 12) P - dark-coloured coarse-grained sandstones; 13) C - triticite sandstones.

tion of the artificial lake in Lokve, including several fossiliferous outcrops with Palaeozoic ammonoids and lyttoniids.

KOCHANSKY-DEVIDÉ (1955), in her paper on Carboniferous fusulinids from the Velebit Mt., mentioned several new fusulinid species from Gorski Kotar, and determined the Carboniferous age of the sedimentary rocks in the vicinity of Mrzla Vodica for the first time.

KOCHANSKY-DEVIDÉ & HERAK (1960) described the Permian species of *Anthracoporella* and *Hicorocodium* from the same area.

KOCHANSKY-DEVIDÉ (1973) wrote about the Trogkofel beds in Croatia. She interpreted the coarse-grained clastic sediments from Mrzla Vodica as being the consequence of redeposition and unstable environmental conditions linked with the tectonic activity. The Trogkofel age of the sediments from Ciganski jarak locality (Fig. 1) has been proved with index species of *Pseudofusulina* and *Robustoschwagerina*. The author observed the two new fusulinid species from Križ potok creek, which will later be described by MILANOVIĆ (1982).

MILANOVIĆ (1982) described in detail the determined microfauna from Križ potok. The most abundant genera at this locality are *Triticites* and *Fusulinella*, with scarce findings of *Schubertella*, *Quasiendothyra*, *Permodiscus*, and *Pseudostafella*. Among the ten taxa, two new species, *Triticites kochanskae* and *Paratriticites croaticus*, were described. Considering the predomination of keriothecal tests, Milanović suggested the post-Kasimovian age for these sediments.

PALINKAŠ & SREMAC (1989) described the barite-bearing stromatolites from the vicinity of Mrzla Vodica, taking into consideration the previous dilemmas on the age of the barite bearing layer. They claimed that the described sediments lie concordantly on the Palaeozoic clastic sediments, and connect the formation of the stromatolites with tidal flats, during the Upper Permian or Lower Triassic.

Although the index fossils of the uppermost Permian have not yet been found in this area, numerous authors consider the sedimentation in Gorski kotar to be continuous during the entire Permian and Lower Triassic periods (see HERAK & TOMIĆ, 1995).

3. PALAEONTOLOGICAL DATA

Micropalaeontological research of all the investigated sedimentary rocks from the vicinity of Mrzla Vodica resulted in numerous findings of Upper Palaeozoic fossils. All together seventy-two taxa have been determined, with predomination of foraminifers (thirty-two taxa) and calcareous algae (twenty taxa, including fifteen dasycladaceans). Macrofossil remnants have also been collected, predominantly calcisponges, ammonoids, bryozoans and echinoderms, together with scarce molluscs, brachiopods and ostracods (Table 1). Over 50% of the determined taxa have been reported for the first time in this region.

Extremely fossiliferous limestone fragments come from conglomerates at the Kosmačev Brijeg and Križ potok localities. These pebbles contain approximately fourty different fossil taxa. Fossils from calclithites appear to be scarce and poorly preserved.

Determination of fossils was based upon the following papers: CONIL & LYS (1964), DUC TIEN (1979), ENDO (1969), FLÜGEL (1980), HOMANN (1972), GRANIER & DELOFFRE (1995), KOCHANSKY-DEVIDÉ (1959, 1970), KONISHI & WRAY (1961), ROUX (1979) and VACHARD (1980).

Almost half of the determined species have rather large stratigraphic ranges, but approximately twenty taxa are strongly indicative of Carboniferous or Permian ages.

Among the Carboniferous taxa, nine species of Viséan small foraminifers (genera *Archaediscus*, *Palaeospiroplectammina*, *Endothyra*) occur (Pl. I, Figs. 4, 5, 7 and 12), together with several Moscovian or Kasimovian species. Moscovian algae (genus *Gyroporella*) are shown on Pl. III, Figs. 1-3, and Kasimovian schubertelids and triticites appear on Pl. II, Figs. 1-4.

Fifteen determined taxa (*Tetrataxis*, *Eflugelia*, *Codiaceae*, *Epimastopora*, *Atractyliopsis*, etc.) range from the Gzhelian to the lowermost Permian, or indicate the Rattendorf-stage of the Lower Permian (see Pl. I, Figs. 8, 9; Pl. III, Figs. 4-6).

Among the taxa that survived throughout the Permian period authors have collected *Tuberitina* (Pl. I, Figs. 2, 3), *Lasiodiscus* (Pl. I, Fig. 2), *Globivalvulina* (Pl. I, Fig. 11), *Pseudofusulina*, *Claracrusta* and *Tubiphytes* (pl. II, Fig. 7). Two lagenid taxa, *Frondina* and *Cryptoseptida* have been previously reported only from the Upper Permian sediments.

4. DISCUSSION

It is a known fact that the age of clastic sedimentary rocks can rarely be precisely determined. Either autochtonous fossils from the matrix are found, or the superposition rule is applied. Bioclasts from the vicinity of Mrzla Vodica are almost always damaged, and are presumably redeposited.

The amount of algae is considerably smaller in fine-grained sediments than in limestone pebbles, varying from approximately 10% in calclithites up to 30% in pebbles, because algal skeletons are less persistent to destruction than foraminiferal tests.

The age of the determined fossils varies from the Lower Carboniferous (Viséan), through the Upper Carboniferous (Moscovian, Kasimovian, Gzhelian), to the Lower Permian (Asselian). Fossils younger than Lower Permian have not been collected during our investigations, but they have been reported by the previous authors. Two specimens of primitive lagenids do not provide sufficient proof for an Upper Permian age.

PROTOZOA	STAROST	Sremac & Aljinović					Milanović	Milanović	Sremac	Bereczi-Makk & Kochansky	Ramovš & Kochansky
ORDO: FORAMINIFERIDA Eichwald, 1830.		KOS. B.	KOS. B*.	KRIŽ	MRZ. P.	JEZ. P.	Križ	Hrvatsko Zagorje	Bačun	Ujfalu	Ortnek
Subordo: TEXTULARIINA Delage & Herouard, 1896.											
1 *Tolypammina glomospiroides* BOGUS & JUFEREV	D - C	●									
Subordo: FUSULININA Wedekind, 1937.											
2 *Eotuberitina reitlingerae* MIKLUHO - MAKLAJ	D_2 - P	●		●	●				●	●	
3 *Tuberitina collosa* REITLINGER	C_2-P	●		●	●				●		
4 *Tuberitina sp.*	C_2-P	●	●	●	●				●	●	
5 *Archaediscus reditus* CONIL & LYS	C_1	●									
6 *Permodiscus sp.*	C	●		●			●				
7 *Eolasiodiscus donbassicus* REITLINGER	C	●						●			
8 *Lasiodiscus minor* REICHEL	P	●								●	
9 *Climacammina elegans* (MOELLER)	C			●				●		●	
10 *Palaeotextularia diversa* TSCHERNYSCHEV	C_1			●							
11 *Deckerella sp.*	C			●				●			●
12 *Palaeotextulariidae gen. et. sp. indet.*	C - P		●	●	●						●
13 *Globivalvulina ex. gr. bulloides* BRADY	C - P			●					●		
14 *Globivalvulina sp.*	C - P			●						●	●
15 *Dagmarita chanakchiensis* REITLINGER	P_1				●						
16 *Palaeospiroplectammina sp.*	D - C_1	●			●			●	●		●
17 *Endospiroplectammina venusta* (VDOVENKO)	C_1	●		●					●		
18 *Glomospiranella ? sp.*	C_1	●									
19 *Pseudolituotubella tenuissima* VDOVENKO	C_1								●		
20 *Planoendothyra spirilliniformis* BRAŽNIKOVA & POTIEVSKAJA	C_1	●									
21 *Planoendothyra sp.*	C_1			●				●		●	●
22 *Endothyra prisca* RAUZER - ČERNOUSOVA	C_1	●							●		
23 *Bradyina sp.*	C_1 - P_1			●				●			
24 *Tetrataxis cf. plana* MOROZOVA	C_2	●									
25 *Tetrataxis conica* EHRENBERG	C - P			●							
26 *Tetrataxis sp. div.*	C - P_1	●		●				●		●	●
27 *Polytaxis maxima* SCHELLWEIN	P_1	●									
28 *Schubertella australis* THOMPSON & MILLER	P		●	●	●					●	●
29 *Schubertella mjachkovensis* RAUZER - ČERNOUSOVA	C_2	●					●	●	●		
30 *Schubertella kingi* DUNBAR & SKINNER	P_1			●					●	●	
31 *Schubertella sp.*	C - P_1	●						●		●	●
32 *Fusulinella cf. bocki* MOELLER	C_2			●			●	●			
33 *Pseudofusulina ? sp.*	P		●							●	●
34 *Triticites kochanskae* MILANOVIĆ	C_2					●	●		●		
35 *Paratriticites croaticus* MILANOVIĆ	C_2		●	●		●	●				
Subordo: MILIOLINA Delage & Hérouard, 1896.											
36 *Apterinella sp.*	C_2 - P			●						●	
37 *Calcivertella ? sp.*	C_2 - P				●			?		?	●
Subordo: LAGENINA Delage & Hérouard, 1896.											
38 *Cryptoseptida sp.*	P_3	●									
39 *Frondina permica* SELLIER de CIVRIEUX & DESSAUVAGIE	P_3			●	●				●		

KOS. B. = KOSMAČEV BRIJEG - IZ VALUTICA (FROM THE PEBBLES)
KOS. B*. = KOSMAČEV BRIJEG - IZ KALKLITITA (FROM CALCLITITES)
MRZ. P. = MRZLICA POTOK
JEZ. P. = JEZERINE POTOK

Table 1 List of the determined taxa from different localities in the vicinity of Mrzle Vodice with stratigraphic ranges and comparative lists.

		STAROST (AGE)	Sremac & Aljinović					Milanović Križ	Milanović Hrvatsko Zagorje	Sremac Bačun	Bérczi - Makk & Kochansky Ujfalu	Ramovš & Kochansky Ortnek
			KOS. B.	KOS. B*.	KRIŽ	MRZ. P.	JEZ. P.					
	SPONGIAE											
40	***Claracrusta calamistriata*** VACHARD	P			●					●		
41	***Asteractinella ? sp.***	P	●		●					●		
42	***Calcispongiae gen. et. sp. indet.***	Pz-rec	●	●	●	●						
43	**GASTROPODA**	Pz-rec	●	●	●	●					●	●
44	**OSTRACODA**	Pz-rec	●		●							
	BRYOZOA										●	●
45	***Fenestella*** 	C - P	●									
46	**Tip A** 	?	●									
47	**Tip B** 	Pz-rec	●	●	●	●						
48	**BRACHIOPODA**	Pz-rec	●		●							
	ECHINODERMATA											
49	***Crinoidea***	Pz-rec	●	●	●	●					●	●
50	***Echinoidea***	Pz-rec	●		●						●	●
	SHIZOPHYTA											
51	***Girvanella permica*** PIA	C_2			●							?
	RHODOPHYTA											
52	***Eflugelia johnsoni*** (E. FLÜGEL)	C_2 - P_1			●				●	●		
	CHLOROPHYTA											
	CODIACEAE											
53	***Anchicodium magnum*** (ENDO)	C_2 - P_1	●									
54	***Eugonophyllum johnsoni*** KONISHI & WRAY	C_2 - P_1							●	●		
55	***Neoanchicodium catenoides*** ENDO	P_1	●		●							●
	DASYCLADALES											
56	***Donezella sp.***	C_2 - P_1	●							●		
57	***Vermiporella ? sp.***	C - P	●									
58	***Anthracoporella spectabilis*** PIA	C - P	●		●				●			●
59	***Gyroporella likana*** KOCHANSKY - DEVIDÉ	C_2			●				●			
60	***Gyroporella constricta*** KOCHANSKY - DEVIDÉ	C_2	●		●				●			
61	***Gyroporella microporosa*** ENDO	P				●						
62	***Gyroporella sp.***	C_2 - J_1	●									●
63	***Pseudogyroporella mizziaformis*** ENDO	C_2 - P	●		●				●			
64	***Epimastoporella alpina*** KOCHANSKY - HERAK	P_1	●							●		●
65	***Epimastopora kroatiaca*** HOMANN	C_2 - P_1	●		●					●		?
66	***Epimastoporella sp.***	C_2 - P									●	
67	***Paraepimastopora kanumai*** ENDO	C_2 - P	●									
68	***Atractyliopsis carnica*** E. FLÜGEL	P_1	●		●							?
69	***Salopekiella sp.*** cf. S. velebitana MILANOVIĆ (?= Ortonella morikawai ENDO)	P	●						●			
70	***Goniolinopsis ? sp.***	P				●						
	PROBLEMATICA											
71	***Tubiphytes obscurus*** MASLOV	C_2 - P	●	●	●	●				●	●	●
72	***Tubiphytes carinthiacus*** E. FLÜGEL	P	●									

The amount of algae varies not only with grain size, but also with the age of clasts. The first diverse microfloral community can be extracted from the Moscovian pebbles, and the most abundant algae have been observed within clasts of Gzhelian to Asselian age.

According to the sedimentological features, the investigated sediments show the greatest similarity to the clastic Trogkofel beds from Ortnek in Slovenia, described by RAMOVŠ & KOCHANSKY-DEVIDÉ (1965). The authors claim that the development of the Trogkofel stage in the vicinity of Mrzla Vodica and Crni Lug could not be very different from that in the Ortnek district. They also presume that the clastic sedimentation in these localities has began in the Lower Permian (RAMOVŠ & KOCHANSKY-DEVIDÉ, 1965, p. 69).

Clastic equivalents of the Trogkofel beds have also been reported from boreholes in southern Hungary, Hrvatsko Zagorje and Medvednica Mt. (BERCZI-MAKK & KOCHANSKY-DEVIDÉ, 1981).

5. CONCLUSION

Clastic sedimentary rocks from the vicinity of Mrzla Vodica in the Gorski Kotar district have been studied at the localities Kosmačev Brijeg hill and the Križ potok, Mrzlica potok and Jezerine potok creeks.

Seventy-two fossil taxa have been determined from conglomerate pebbles and calclithites, among which more than half are newly described in this region.

The most abundant fossils are foraminifers (thirty-nine taxa) and calcareous algae (twenty-two taxa). These species are in association with macrofossils (sponges, molluscs, ostracods, bryozoans, brachiopods and echinoderms).

Approximately half of the determined species are indicative of particular periods in the Carboniferous (Viséan, Moscovian, Kasimovian, Gzhelian) or the Lower Permian (Asselian), while the other taxa show a wider stratigraphic range. Marine Trogkofel fossils have been reported by previous authors. Therefore a continuous marine sedimentation from the Lower Carboniferous (Viséan) up to the Trogkofel stage has been presumed for this area.

Foraminifera predominate in Viséan and Kasimovian clasts, and calcareous algae are most abundant in the Moscovian pebbles, as well as in Gzhelian to Asselian clasts. Therefore, a variation of sea level can be presumed, with extremely shallow water conditions during the Moscovian and at the Carboniferous/Permian border.

It has been concluded that the uplift of the sedimentary basin in the study area began after the Lower Permian, enabling deposition of the molasse deposits. Shallow-marine sedimentation was restored presumably in the Lower Triassic. Sedimentologically, these sedimentary rocks show the greatest similarity with the clastic Trogkofel beds of the neighbouring areas.

The age of the investigated clastic sediments could not be precisely determined. Nevertheless, it can be concluded that they are younger than the Lower Permian.

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PLATE I

Foraminifers

1 *Tolypammina glomospiroides* BOGUS & JUFEREV; x 50.

2 *Tuberitina collosa* REITLINGER, *Lasiodiscus minor* REICHEL; x 25.

3 *Eotuberitina reitlingerae* MIKLUHO-MAKLAJ; x 50.

4 *Planoendothyra* sp.; x 50.

5 *Archaediscus reditus* CONIL & LYS; x 50.

6 *Palaeotextularia* sp.; x 50

7 *Palaeospiroplectammina* sp., *Bradyina* sp.; x 50.

8 *Tetrataxis conica* EHRENBERG; x 25.

9 *Tetrataxis* sp.; x 25.

10 *Tetrataxis* cf. *plana* MOROZOVA encrusted with tubiphytes and bryozoans; x 50.

11 *Globivalvulina* ex gr. *bulloides* BRADY; x 40.

12 *Planoendothyra spirilliniformis* BRAŽNIKOVA & POTIEVSKAJA, *Epimastoporella alpina* KOCHANSKY & HERAK, *Fenestella* sp.; x 40.

Age and locality:

1 Carboniferous, Kosmačev Brijeg (from the pebble).

2-3 Permian, Kosmačev Brijeg (from the pebble).

4 Lower Carboniferous (Viséan), Križ potok.

5, 7, 12 Lower Carboniferous (Viséan), Kosmačev Brijeg (from the pebble).

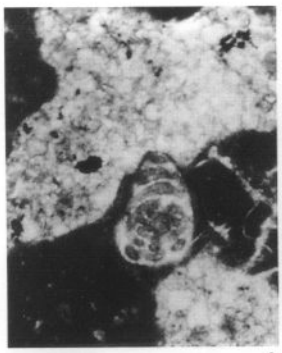
6 Carboniferous or Permian, Kosmačev Brijeg (from calclithites).

8 Carboniferous or Permian, Križ potok.

9, 10 Upper Carboniferous (Moscovian), Kosmačev Brijeg (from the pebbles).

11 Carboniferous or Permian, Križ potok.

12 Lower Carboniferous (Viséan), Kosmačev Brijeg (from the pebbles).



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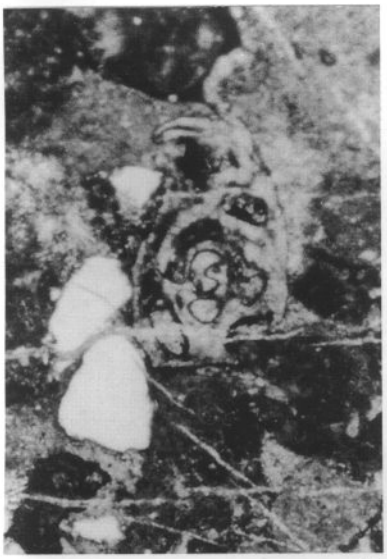

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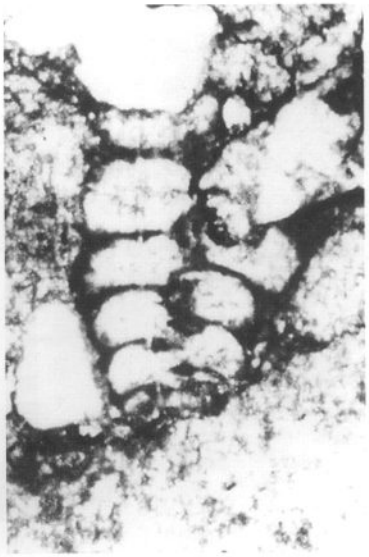

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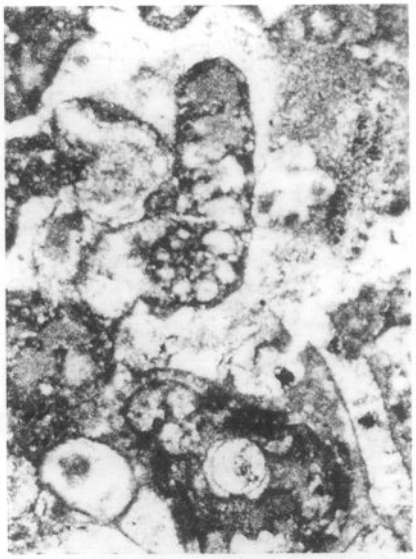

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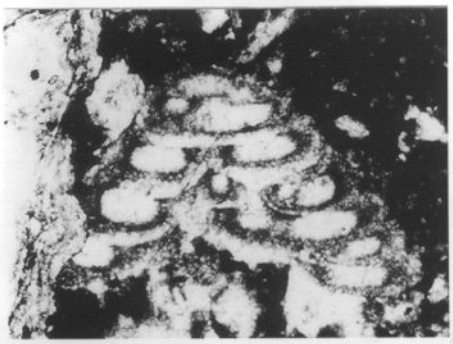

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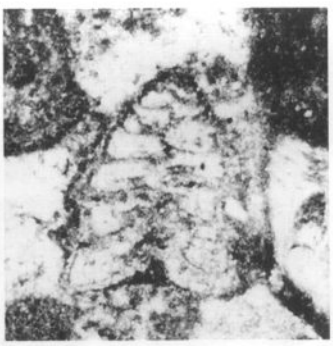

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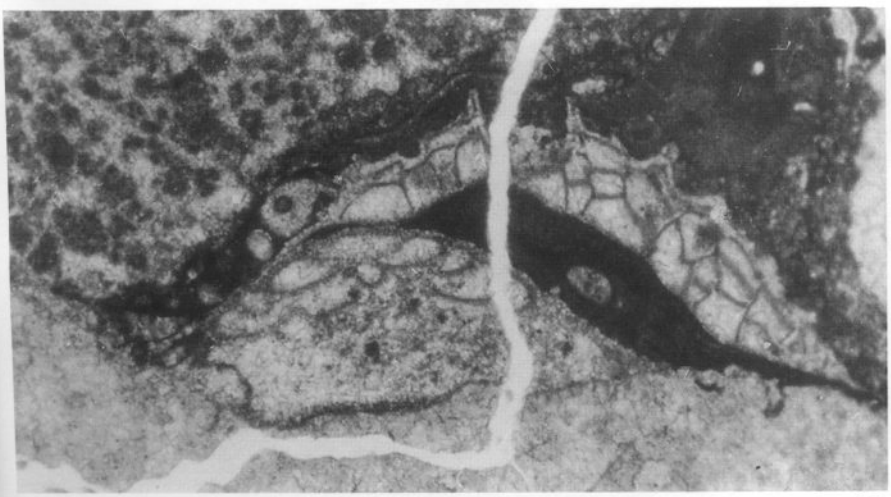

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PLATE II

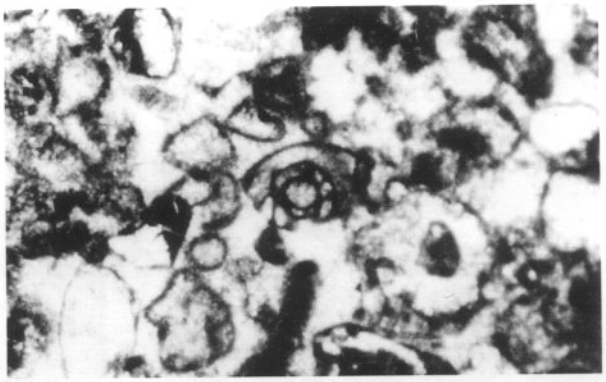
Fusulinids and microfossil particles

1 *Schubertella kingi* DUNBAR & SKINNER; x 50.
2 *Schubertella australis* THOMPSON & MILLER; x 50.
3 *Triticites kochanskae* MILANOVIĆ; x 50.
4 *Paratriticites croaticus* MILANOVIĆ; x 50.
5 *Epimastoporella alpina* KOCHANSKY & HERAK, *Apterinella* sp.; x 50.
6 *Cryptoseptida* sp.; x 50.
7 *Tubiphytes carinthiacus* E. FLÜGEL within the brachiopod shell; x 10.
8 Ostracods in the central cavity of a calcisponge; x 25.

Age and locality:

1-2, 5 Lower Permian (Asselian), Križ potok.
3 Upper Carboniferous (Kasimovian), Jezerine potok.
4 Upper Carboniferous (Kasimovian), Kosmačev Brijeg (from calclithites).
6 ?Upper Permian, Kosmačev Brijeg, (from the pebble).
7, 8 Permian, Kosmačev Brijeg (from the pebbles).

1



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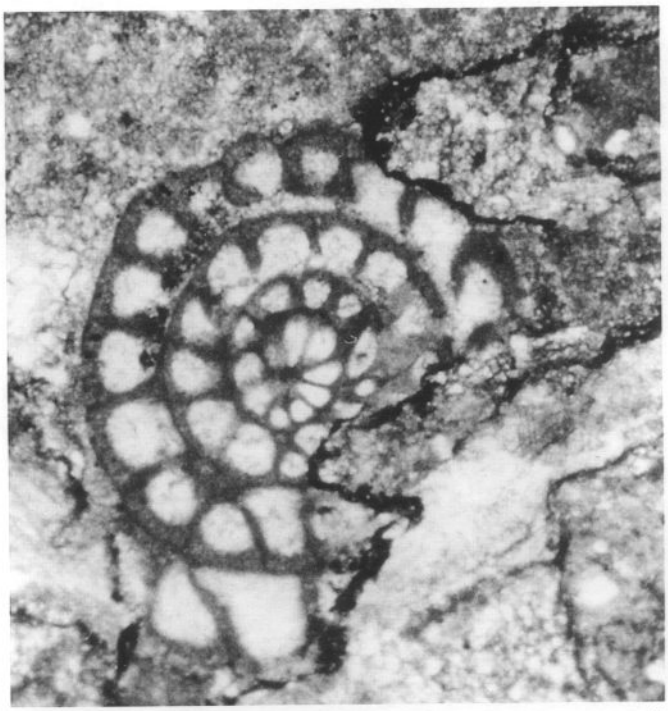

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PLATE III

Calcareous algae

1, 2 *Gyroporella likana* KOCHANSKY-DEVIDÉ; x 25.

3 *G. constricta* KOCHANSKY-DEVIDÉ; x 25.

4 *Epimastopora kroatiaca* HOMANN, *Atractyliopsis carnica* E. FLÜGEL; x 50.

5 *Epimastoporella alpina* KOCHANSKY & HERAK; x 25.

6 *Neoanchicodium catenoides* ENDO encrusted with *Girvanella permica* PIA; x 50.

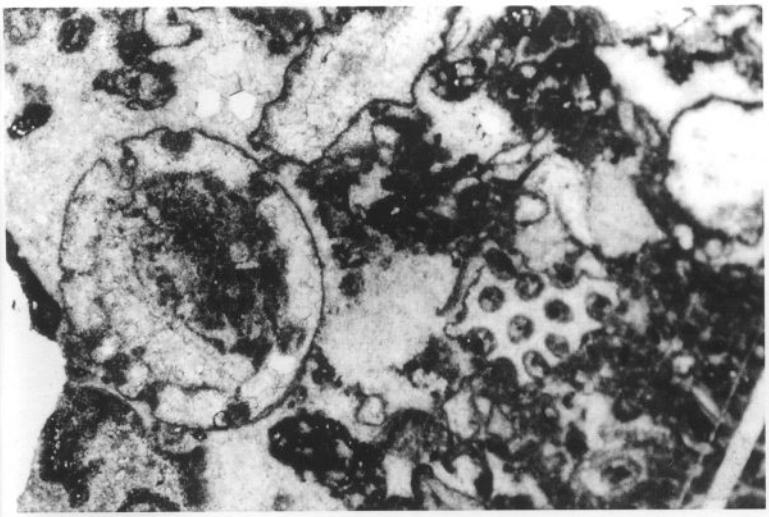
7 *N. catenoides, Anthracoporella spectabilis* PIA, macrofossil fragments encrusted with thick cyanobacterial crusts; x 10.

Age and locality:

1-3 Upper Carboniferous (Moscovian), Križ potok.

4-5 Lower Permian (Asselian), Kosmačev Brijeg (from the pebbles).

6-7 Lower Permian (Asselian), Križ potok.



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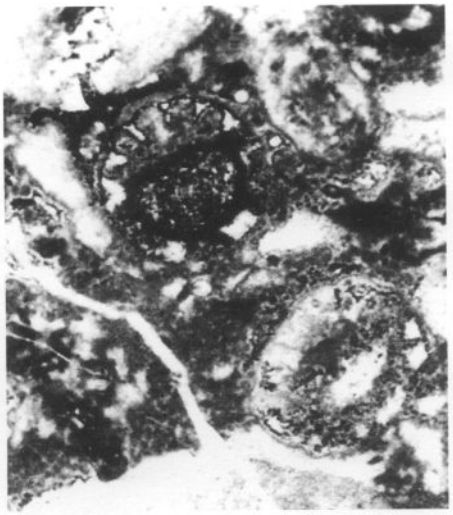

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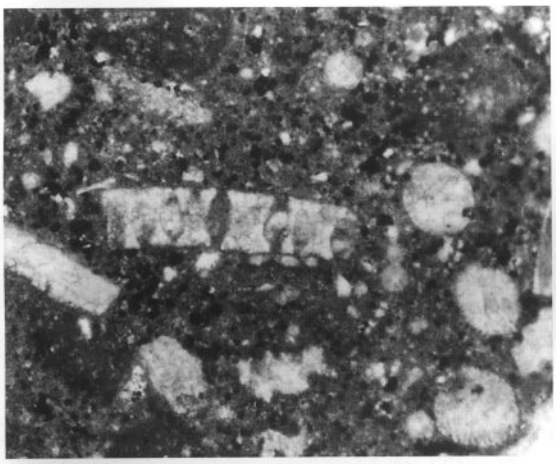

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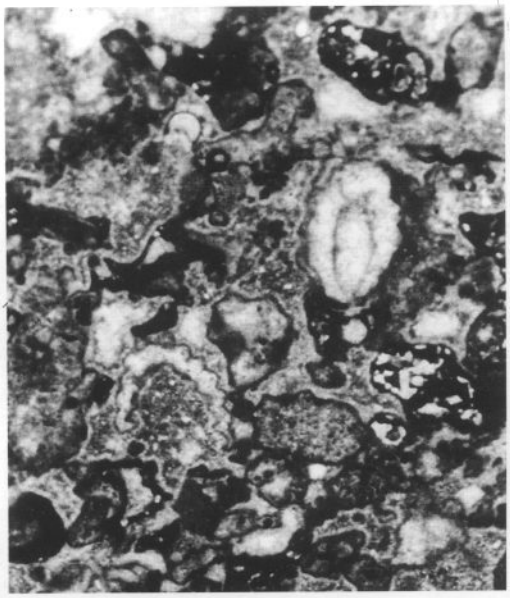

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