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Upper Jurassic and Lower Cretaceous scleractinian corals from the exotic pebbles - Pieniny Klippen Belt, Slovakian West Carpathians.

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Abstract: Totally 23 coral taxa from the exotic pebbles belonging to Upper Jurassic and Lower Cretaceous limestones were identified and compared with coral associations described from 29 states with the purpose to search for the area of their origin.

Key words: corals, Upper Jurassic, Lower Cretaceous, exotic pebbles, Pieniny Klippen Belt, West Carpathians.

Introduction

The Upper Jurassic and Lower Cretaceous scleractinian corals were identified from the exotic limestone pebbles from Upper Cretaceous (Albian-Senonian) conglomerates occurring in Slovakian Peri-Pieniny and Pieniny Klippen Belt, Western Carpathians. They developped originally in shallow and warm Tethyan environment.

The collection is composed of several fragmentary coral skeletons. Their dimensions are small, from 1 to several centimetres only. On the basis of about 40 thin-sections, 23 coral taxa were identified (Tab. 1); 13 species and 10 taxa on the generic level only. They represent 20 genera.

This small coral fauna, though poorly preserved and in fragments only, appears similar, though less diversified in species, to those known from the Upper Jurassic and Lower Cretaceous (Urgonian facies) shallow-water facies from the European Tethyan and epicontinental provinces. Some, but not numerous, species are also common with those known from East Europe (Crimea, Caucasus) and Asia, i.e. from Tibet, India, Japan (Tab. 2).

Consideration about the origin of exotic rocks from pebbles.

Described limestone pebbles with corals proceed from the Albian to Senonian polymictic conglomerates of the Pieniny and peri-Pieniny Klippen Belt; they are traditionally named Upohlav Conglomerates. More than hundred types of rocks, predominantly carbonates, were determined (their inventory was summarized by Mišík & Marschalko, 1988, p.100-102). An exotic character is clear in comparison with the rocks of internal adjacent zones - Tatric and Fatric Units, as well as with the neighbouring external one, i.e. Magura Unit, and they are exotic also in the relation to the rocks of the klippen in the Pieniny Klippen Belt.

Typical exotics are: a block of coal with Namurian sporomorphs, blocks of dark Paleozoic quartzose conglomarates, pelagic Triassic limestones with conodonts of Anisian, Ladinian, Carnian, Norian and Rhaetian age (cf. Mišík and Marschalko, 1986, fig. 1; conodonts are totally absent in the neighboring Tatric Zone), Ladinian-Carnian Wetterstein limestones with Dasycladaceae and foraminifers, shallow-water Upper Jurassic limestones with *Protopeneroplis striata*, *Mohlerina basiliensis*, Urgonian limestones of Barremian-Aptian age with Dasycladaceae (seven species never found in outcrops in the Western Carpathians - Soták & Mišík, 1993), with ophiolite detritus also absent in outcrops of Urgonian limestones (mainly chromian spinels, fragments of serpentinite and glaucophane grains - i.e.the material of subduction mélange and obducted ultrabasic rocks from the upper mantle under oceanic crust, evidenced also by pebbles of gabbro, basalts, andesites and metabasalts BABB with low and high pressure metamorphism). Granite pebbles are different from those of the Central Carpathians. Pebbles of acid volcanic rocks are also absent in the neighbouring zones.

As similar rocks are present in outcrops only in the innermost zones of the Western Carpathians, a contact of Meliata + Silica Units with Peri- pieniny Zone in the pre-Upper Cretaeeous time might be supposed ("Meliata – Pieniny or Meliata-Klape ocean"). In that case a large lateral shift of Central Carpathian Block from the East should take place.

Mišík & Marschalko (1988, fig. 7-9) discussed further possibilities: a long transport of pebbles from SW or S, a transport of lithified conglomeratic bodies by lateral shift from the East.

The direct transport of pebbles during the Albian to Senonian from the Meliata-Silica sedimentation area is excluded from the geological reasons. They cannot be derived from the frontal parts of prograding Silica and Choč nappes, because they arrived in the proximity of the future Klippen Balt only in Lower Turonian.

Localities of exotic-bearing deposits in Slovakia / Species	Vrtižer-n	Vrtižer-III	Nosice-II-f	Nosice-III-c	Chlmec-lom/IIc	Krivá-f	Krivá-i	Krivá-q	Zástranie-la	Divinka-g
Amphiaulastrea sp.							▲			
Mitrodendron sp.					▲					
Pleurophyllia sp.	▲					▲				
?Pleurostylina sp.				▲						
Aplosmilia semisulcata (Michelin, 1843)		▲								
Stylosmilia corallina Koby, 1881					▲	▲				
Stylosmilia sp.					▲	▲				
Pseudocoenia cf. *slovenica* Turnšek, 1972	▲									
Proaplophyllia sexradiata (Roniewicz, 1966)		▲								
Enallhelia cf. *differencia* Eliašova, 1981	▲									
Apocladophyllia sp.				▲						
Thecosmilia dichotoma Koby, 1884						▲				▲
Clausastrea saltensis Alloiteau, 1960							▲			
Felixigyra patruliusi Morycowa, 1971							▲			
Felixigyra sp.							▲			
Calamophylliopsis moreauana (Michelin, 1843)	▲					▲				
Calamophylliopsis stockesi (M. Edw. et H., 1851)					▲					
Mesomorpha excavata (d'Orbigny, 1849)									▲	
Fungiastraea sp.				▲						
?Thamnoseris delorenzoi Prever, 1909			▲							
Latomeandra sp.					▲					
Latiastrea sp.							▲			
Microsolena distefanoi (Prever, 1909)								▲		

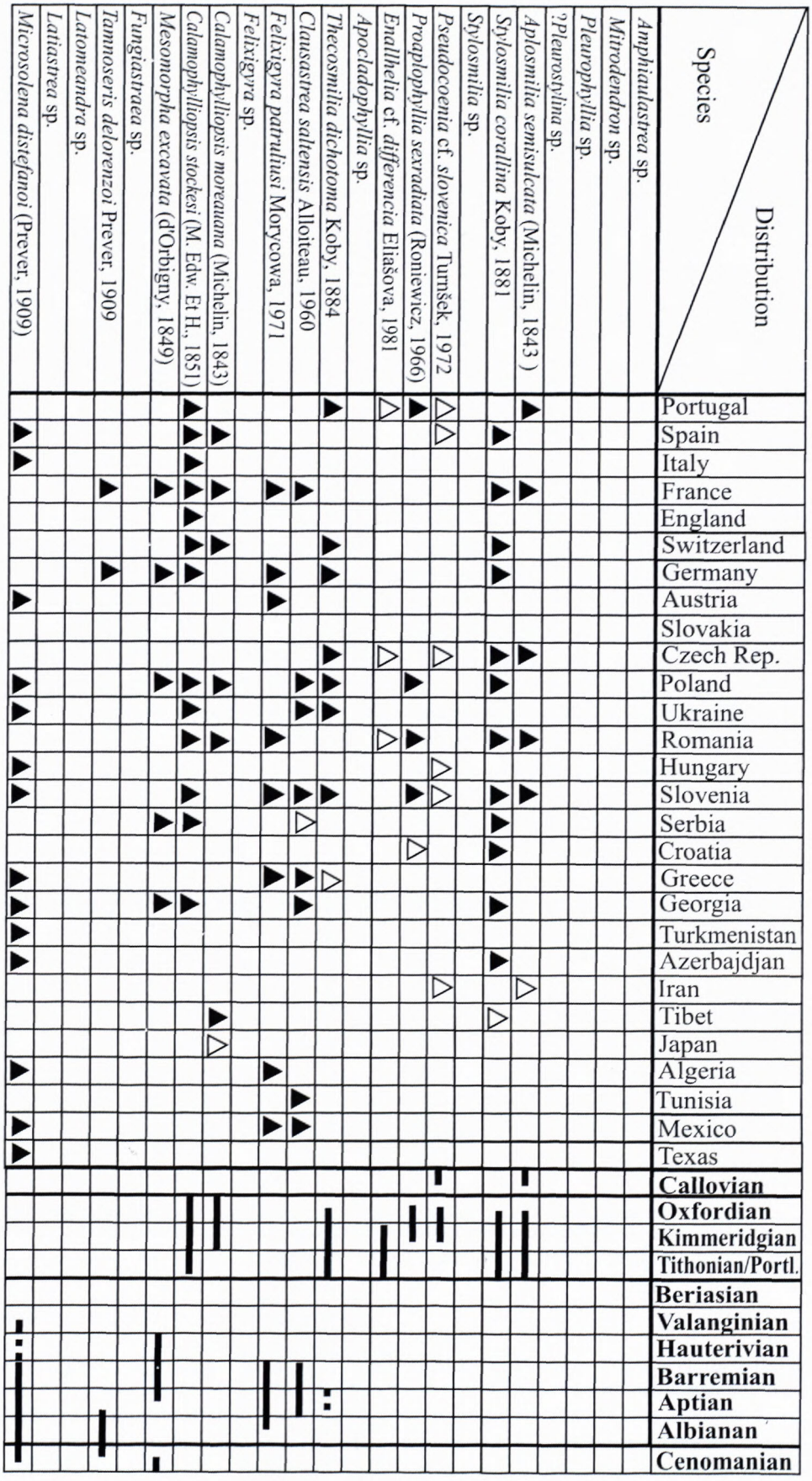
Tabl.1. Mentioned localities with scleractinian corals of exotic-bearing deposits (conglomerates) in Slovakian Pieniny Klippen Belt (Carpathians).

Plašienka (1996 and elswhere) suggested another solution – a large transport of Klape Nappe consisting mainly from Albian strata with conglomerates sliding upon the Middle Cretaceous clastic of Fatric and Tatric units (Poruba. Fm.). The exotic pebbles should proceed from the Veporic elevation (so-called Andrusov Mountains). Naturally, this theory cannot explain the presence of the same exotics in the Eastern Alps (Losenstein Fm.), in the Eastern Slovakia (Proč Conglomerates) and Carpathian Ukraine (Vulchovchik Conglomerates), because Klape Unit is absent there. Numerous rocks such as the huge quantity of dolomites, Urgonian limestones, Namurian coal is not possible to derive from the Meliata space and its frontal parts.

On the other hand, the previous hypothesis about an exotic Pieniny (or Andrusov) Cordillera emerging between Klape and Kysuca-Pieniny sedimentary zones is handicapped by absent evidencies of tectonic movements, metamorphism and volcanic activity during the Lower Cretaceous in the area of future Pieniny Klippen Belt.

The source area of mentioned exotics were probably scales of accreting wedge from the subduction mélange partly emerged as an exotic ridge. Directly on the emerged ridge, sintres and fresh-water limestones with Characeans were formed. Littoral fine-grained conglomerates from the margin were destroyed by continuing raising of the ridge (canibalism). They occur as blocks with pebbles dedolomitized under the hypergenetic conditions. A rich association of sporomorphs and leaves of terrestric plants proved the existence of that dry land. The documentation of these facts is in Mišík & Sýkora (1981).

The crucial question, from what direction the exotic pebbles were transported, can be answered only by detailed study of rocks as well as fossils found in pebbles. We are inclined to favorise the transport from SE. In the eastern part of the Klippen Belt there is frequent pyroclastic admixture in the Berriasian (Proč Conglomerates), as well as in Barremian-Aptian limestone pebbles. Abundant basic volcanism is known in those horizons in Pieniny and Rachov zones of Carpathian Ukraine. Volcanic admixture was found also in pebbles of Middle Liassic and Oxfordian. Volcanic rocks of the same age are known in Rachov Zone, also in Poiana Botizei and in Southern Carpathians. Dasyclad alga *Montiella elitzae* was found only in Georgia, Bulgaria and Romania (Masse & Bucur , 2002) it occurred in an exotic pebble in Slovakia. Foraminifera *Archaelveolina reicheli* was described from the Aptian of Italy and was present in a pebble of Upohlav conglomerates with Barremian fora-



Tabl. 2. Geographic and stratigraphic distribution of the Jurassic and Cretaceous scleractinian corals in he Slovakian Pieniny Klippen Belt.

▲ – species identified as certain., Δ and --- : species described as affinis, conformis or doubtful determination.

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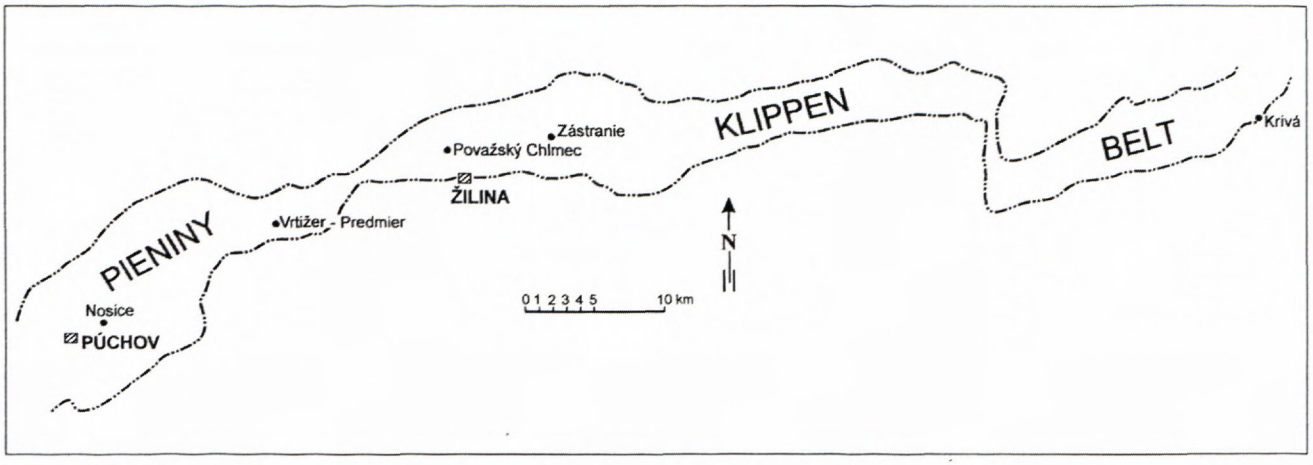

Fig. 1. Topographic map showing the localities (black spots) from which the analysed material was collected.

minifers (Mišík & Sýkora, 1981, p.36). Indication of the source area of exotics can be expected mainly from the detailed study of foraminifers from exotics not realized up till now. We hoped to gain some indications also from the study of corals from the pebbles presented here, but more data from some countries are needed for comparison.

On the other hand some hints might be expected also from the negative conclusions, such as the total absence of Carboniferous and Permian fusulinids, Liassic limestones with *Lithiotis*, *Orbitopsella praecursor*, *Paleodasycladus mediterraneus* etc. among the exotic pebbles, so abundant in the territory of Italia and former Yugoslavia.

Appendix
Description of thin sections of exotic limestones with scleractinian corals (see Fig. 1)

Nosice-II-f (loc. 11, thin section No. 6651). Klape Unit, Albian conglomerates. Probably Urgonian facies (Barremian-Aptian). Previously determined *Microsolena* sp. Unsorted biomicrudite. It contains corals, hydrozoans, bivalvian fragments, brachiopods, coralline algae (including *Lithothamnium* sp.), *Ethelia alba* (Pfender), textularid and encrusting foraminifers including *Kosktinobullina socialis* Cherchi et Schroeder, ostracods, echinoderm plates, spines of echinids.

Recently from the exotic limestones (biomicrite, biointramicrite) from these conglomerate one coral species has been identified, *?Thamnoseris delorenzoi* Prever. This species is known to now from Early-Mid Cretaceous (Upper Aptian-Lower Cenomanian).

Nosice-III-c (loc. 12 , thin section No. 6661). Klape Unit, Albian- Cenomanian conglomerates. There are corals, thick-shelled bivalvians with original, calcite structure bored by boring algae, some *Bacinella irregularis* Radoičić, *Ethelia alba* (Pfender), ostracods, foraminifers encrusting corals, tubes of serpulid worms, rotalid foraminifers. Admixture of clastic silt quartz (up to 0.15 mm), one grain of chromian spinel and a tiny fragment of serpentinite. The limestones are probably Barremian-Aptian (?).

Vrtižer (loc. 29, thin section No.6336), now Vrtižer-Predmier SE from Považská Teplá. Klape Unit, age of the conglomerate is Senonian. Previously were determined *Stylosmilia* sp., *Calamophylliopsis* sp., *Pleurophyllia* sp. (aff. *minuscula* Kon.). Associated with *Cladocoropsis mirabilis* Felix (partly silicified), *Codiaceae*, echinoderm plates, encrusting foraminifers, problematic algae and bivalvian fragments.

Some scleractinian corals from the same location (Vrtižer-n, No 6983) have been identified, as i.a., *Calamophylliopsis moreauana* (Michelin), *Pseudocoenia* cf. *slovenica* Turnšek and *Enallhelia* cf. *differencia* Eliašova. *Pleurophyllia* sp. and *Stylosmilia* sp. also occur there.

From other thin sections from the exotic limestones (micrite, pelsparite) coming from Vrtižer (Vrtižer-III) the following Late Jurassic scleractinian corals have been identified: *Aplosmilia semisulcata* (Michelin) and *Proaplophyllia* sexradiata (Roniewicz).

The whole Vrtižer coral assemblage indicates Late Jurassic age, more precisely Oxfordian-Tithonian.

Považský Chlmec-c (loc.37, thin section No. 6825). Small quarry, Kysuca-Pieniny Unit, age of the conglomerate - Coniacian. Previously determined *Calamophylliopsis* cf. *stokesi* (Milne Edwards et Haime), photo in Mišík & Sýkora (1981, tab.VI, fig.4). Supposed age according to the coral taxon is Upper Oxfordian - Kimmeridgian. Thin section: Biopelmicrite to biolithite. Corals are partly silicified by the aggregates of quartzine, abundant *Tubiphytes obscurus* Maslov, *Bacinella irregularis* Radoičić, *Aeolisaccus* sp., nubecularid foraminifers , *Koskinobullina socialis* Cherchi et Schroeder, rarely rhaxa (spicules of silicisponges) filled by calcite, single fragments of serpulid tubes,ostracodes, spines of echinids, plate of crinoid, fragment of dasyclad alga, *?Pseudocyclammina*, fragment of bryozoan. Without terrigenous admixture.

Recently from the Chlmec exotic limestones (biointrasparite; Chlmec-lom/IIc, No 6981) the following coral taxa have been identified: *Mitrodendron* sp., *Stylosmilia corallina* Koby, *Stylosmilia* sp., *Calamophylliopsis stockesi* (M. Edwards et Haime) and *Latomeandra* sp. These coral faunas additionally confirm the Early Jurassic age of the exotic limestones in which they occur.

Zástranie-I-a (loc.42). Kysuca-Pieniny Unit, Coniacian conglomerates. Previously determined *Mesomorpha excavata* (d'Orb.) – occurring from the Hauterivian to Aptian. It is figured in Mišík& Sýkora (1981, tab.X, fig.3). Description of thin section: Urgonian facies Upper Barremian-Lower Aptian. Biosparite to biosparrudite. Abundant *Palorbitolina lenticularis* (Blumenbach), colonial corals; thick bivalvian shells bored by algae *Paleachlya*, rare *Textularia* sp., miliolid, *Ethelia alba* (Pfender) and echinoderm plate.

Divinka-g (loc.35), Kysuca-Pieniny Unit, Coniacian conglomerates. Previously determined *Thecosmilia* cf. *dichotoma* Koby. In association *Clypeina jurassica* Favre was found. Evidently Kinmeridgian-Tithonian. Lately other specimens of *Thecosmilia dichotoma* Koby have been found there (thin section No 7603).

Krivá-f-railway (loc.55). Klape Unit, Cenomanian-Turonian conglomerates. Light grey biohermal limestone. In the thin sections abundant recrystallized corals, rare *Bacinella irregularis* Radoičić and a gastropod. The preliminary determination of corals (*Calamophylliopsis* sp., *Complexastraea* sp. and *Thecosmilia* sp., mentioned in Misik& Sykora 1981) has now been made more precise: *Calamophylliopsis moreauana* (Michelin), *Thecosmilia dichotoma* Koby. Moreover *Pleurophyllia* sp., *Stylosmilia corallina* Koby and *Stylosmilia* sp. have been identified. The corals indicate Late Jurassic age.

Krivá-i the dark grey exotic limestones (micrite, pelmicrite) with corallum fragments. The following taxa have been distinguished: *Amphiaulastrea* sp., *Clausastrea saltensis* Alloiteau, *Felixigyra patruliusi* Morycowa, *Felixigyra* sp. and *Latiastraea* sp. These taxa are known from Lower Cretaceous, more exactly from Barremian-Aptian.

Krivá-q (the same locality No. 55). Previously determined *Microsolena distefanoi* (Prever), stratigraphic span Barremian to Cenomanian. It is probably Urgonian facies (Barremian-Aptian; Mišik, 1990, p. 34). Coral limestone biomicrudite to biolithite. Only coral skeleton in the thin section, partly silicified.

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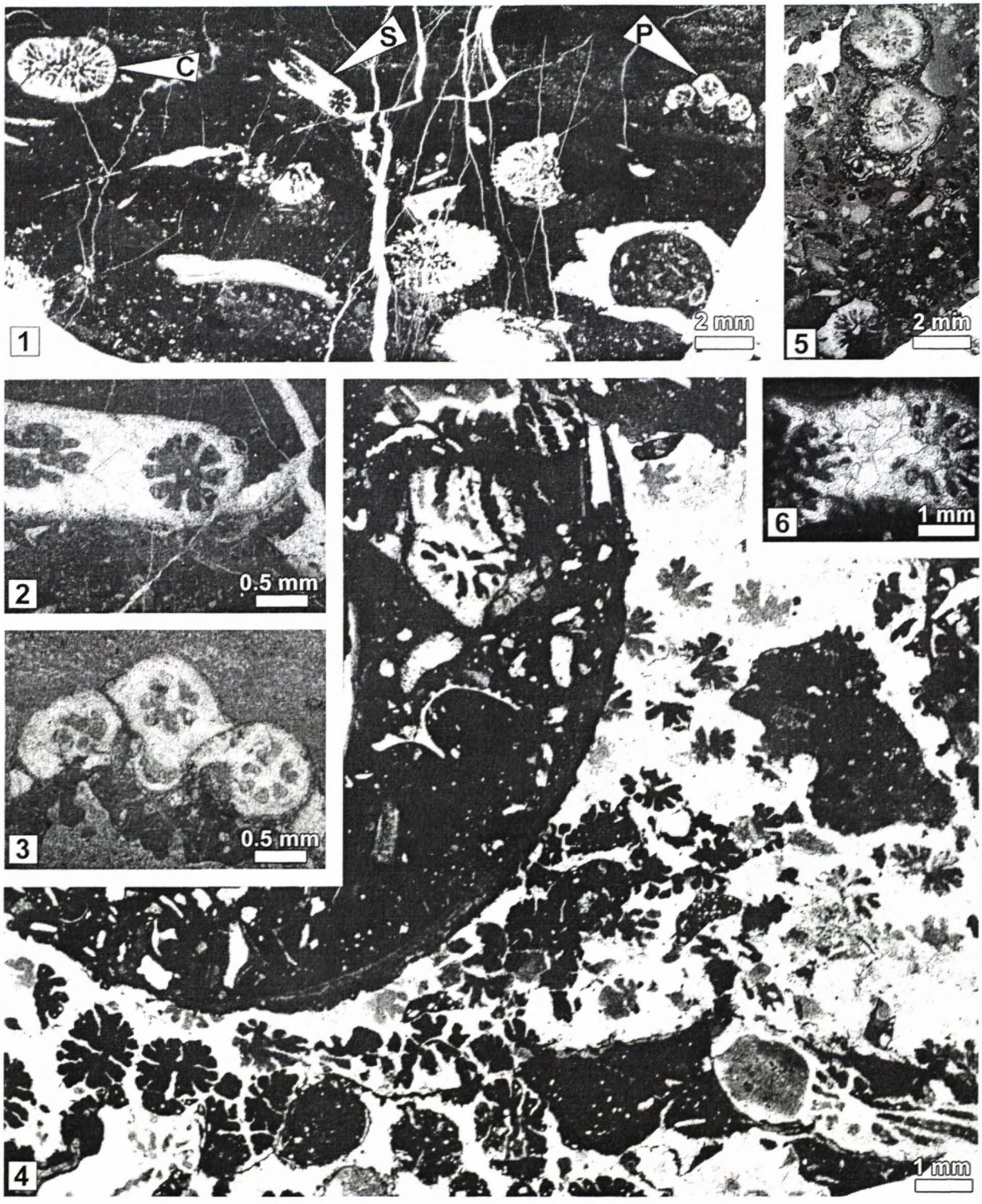
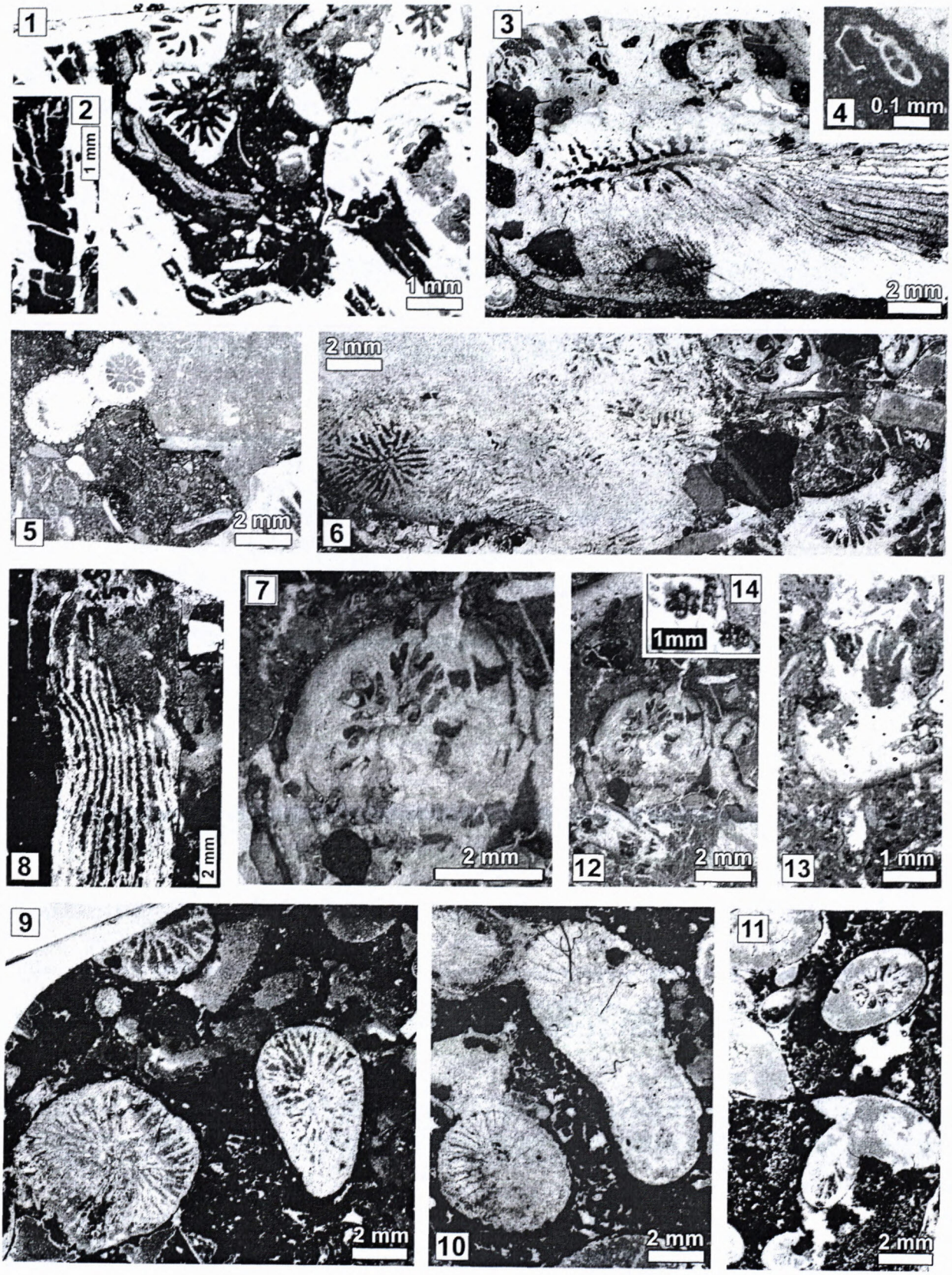


Fig. 2: 1. Fragments of scleractinian corals in micritic limestone from Krivá-f conglomerate; C- *Calamophylliopsis moreauana* (Michelin), E- *Stylosmilia* sp., P- *Pleurophyllia* sp.; 2- enlarged corallite branch (S) from Fig. 2:1 showing hexameral septal symmetry and small styliform columella; 3- enlarged fragment of three corallites marked in Fig. 2:1 as P. Note very small diameter of corallites and bilateral symmetry of their septa, 4- *Pleurostylina* sp., Nosice-III-c, fragment of cerioid colony in transverse section. Note the fragment of *Apocladophyllia* branch in the micrite (at the top of the picture); 5- *Stylosmilia corallina* Koby, Krivá-f, transverse section; 6- transverse section of *Calamophylliopsis* fragment from the limestone pebble from Krivá-f.

Fig. 3: 1, 2 – *Apocladophyllia* sp, Nosice-III-c, transverse section of corallites (in 1) and longitudinal one (in 2); 3 – *Aplosmilia semisulcata* (Michelin), Vrtižer-III, transverse, slightly oblique section of corallite; 4 – *Globotruncana*-like form occurring in the conglomerate matrix near *A. semisulcata*; 5 – *Proaplophyllia sexradiata* (Roniewicz) in same limestone pebble; 6 – *Latiastrea* sp., Krivá-i, transverse section of colony. Note in lower right-hand corner a corallite representing *Amphiaulastrea* genus; 7 – *Mitrodendron* sp., Chlmec-lom/IIc, transverse section of corallite; 8 – *Calamophylliopsis stockesi* M. Edwards & Haime,



same site, one corallite fragment in longitudinal section; 9 – *Latomeandra* sp., same site, transverse thin section of several corallites, 10 – *Calamophylliopsis stockesi*, same site, transverse section of corallites; 11– *Stylosmilia corallina* Koby, same site, corallites in transverse section; 12 – one corallite of *Mitrodendron* sp. (same section as in 7) with small branch fragment of *Stylosmilia* sp.. *Enallhelia* cf. *differencia* Eliašova, Vrtižer-n, longitudinal-oblique section of the fragment of branching colony.

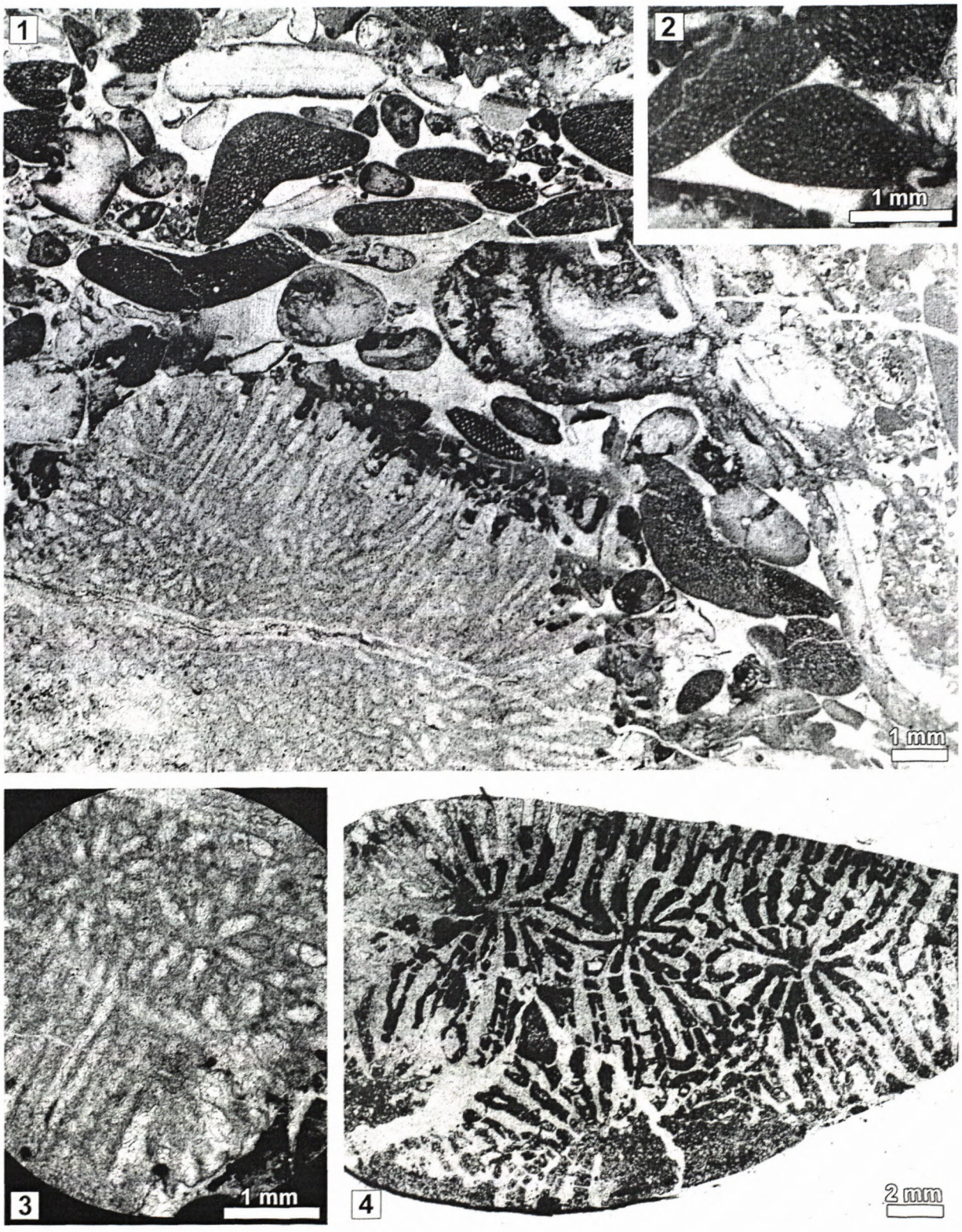


Fig. 4: 1 – 3. Biointrasparite with abundant bentic foraminiferids (such as *Orbitolina* sp.) and small thamnasterioid-subcerioid coral colony *Mesomorpha excavata* (d'Orbigny), Zástranie-Ia: 2 – some orbitolinids from thin section, a part of which is presented in 4:1; 3 – enlarged fragment of coral colony from Fig. 4:1; 4 – transverse thin section of *Clausastrea saltensis* Alloiteau, Krivá-i.

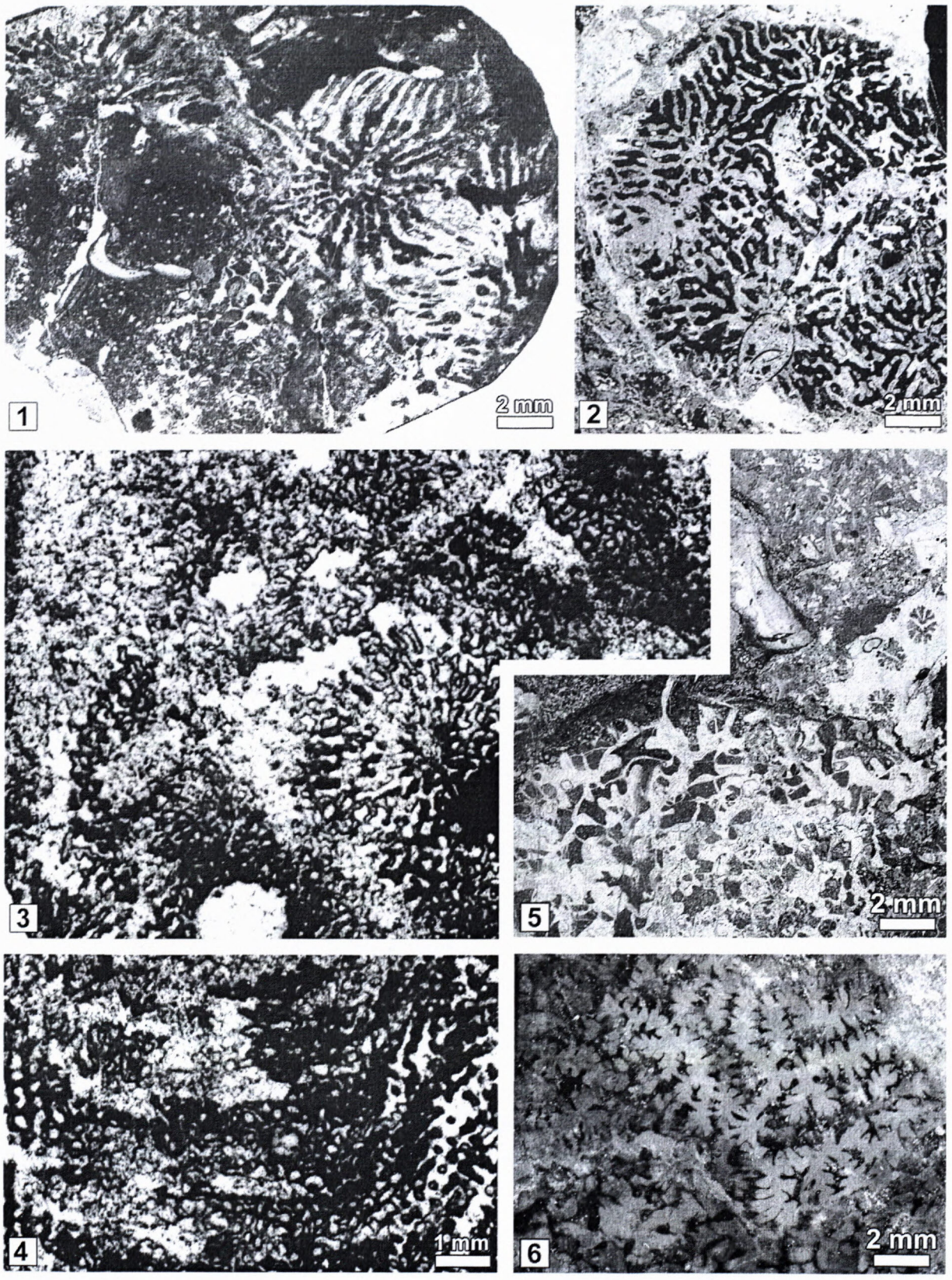


Fig. 5: 1– *Fungiastraea* sp., Nosice-IIIc; transverse section of a fragment of a colony; 2 – *Thamnoseris delorenzoi* Prever, Nosice-II f, transverse thin section of the small colony; 3, 4 – *Microsolena distefanoi* (Prever), Krivá-q: 3 – transverse section, 4 – longitudinal section of colony fragment; 5 – *Felixigyra* sp. and small portion of the stylinid colony; 6 – *Felixigyra patruliusi* Morycowa, Krivá-i, transverse thin section of the fragment of meandroid-hydnophoroid colony.