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Biostratigraphical and Sedimentological Studies of the Namurian Beds in the Ostrava-Karviná Coal District

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V moravské části hornoslezské karbonské předhlubně se objevují dvoufázové typy cyklothem. Jejich spodní oddíly ukazují jednoduchou nebo složitou vertikální i regionální gradaci anorganogenního i fytogenního materiálu od basálního hrubozrnného sedimentu po jílovcový strop sloje. Svrchní oddíly cyklothem tvoří pozvolna usazované jalové jílovce, v nichž se někdy objevují vložky s faunou a neplně vyvinutá křídla spodních oddílů cyklothem usazených v sousedních oblastech. Ve fosiliferních vložkách se velmi často objevují směsi odlišně fosilisovaných jedinců. Dvouchlopňové schránky drobných a nevyspělých jedinců jsou téměř vesměs sevřené, kompletní, a bývají vyplněny jiným materiálem (křemenem, pyritem, kalcitem) než tím, v němž jsou uloženy. V některých fosiliferních polohách je zvlášť dobře možno sledovat vytřídění fosilií podle velikosti a tvaru. Fosilie nejsou na původním místě. Byly občas snášeny do hlubších prostorů předhlubně nevhodných k životu a vytvářely tam fosiliferní vložky v pozvolna se usazujících jalových jílech. Tyto okolnosti způsobují velké obtíže při identifikaci jednotlivých pater s faunou, poněvadž faunistický obsah jednotlivých fosiliferních vložek se často nápadně liší jak druhy organismů, tak způsoby jejich fosilisace. Mimo to jednotlivé polohy mívají velmi různý (často jen čistě místní) regionální rozsah.

Vzhledem k těmto okolnostem byly při mikrofaunistické prospekci zjišťovány různé jiné korelační možnosti. Slibné metody jsou popsány. Poněvadž gradace materiálu ve spodních oddílech cyklothem ukazuje spolu s četnými jinými zjevy (uložení kořenových částí a druhy jejich výplní, zonárnost výskytu jednotlivých druhů rostlinných zbytků) na frakcionovanou sedimentaci, spodní oddíly musí být zkoumány moderními sedimentologickými metodami jako celky. Jakmile budou poznány zákonitosti o vztazích jednotlivých druhů sedimentů a jejich regionálním rozšíření, bude možno přistoupit ke spolehlivější korelaci jednotlivých cyklothem.

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INTRODUCTION

The subject of the writer's investigation was the Ostrava beds in the Ostrava-Karviná coal district in the Moravian part of the Upper-Silesian foredeep. These beds form the lower part of coal-bearing sediments. The general belief is that they represent the Namurian A. There are, however, indications that their uppermost part (Gaebler's faunal band and seam Prokop) may belong to the lowermost Namurian B.

The Ostrava beds are divided upwards into four zones: the Petřkovice zone, the Hrušov zone, the Jaklovec zone and the Poruba zone. All these zones contain layers with a marine fauna as well as layers with a freshwater and with a mixed fauna.

The purpose proper of the first phase of the investigation here desribed was to collect microfossils from all marine-fauna bands and to find out the rules governing the distribution and general composition of microfaunas. In the microfaunal prospection attention was paid to all phenomena that could be made use of in the correlation of individual cyclothems.

SAMPLING FOR THE MICROFAUNAL INVESTIGATION

The first system of sampling was based on the presupposition that all fossiliferous sediments in paralic coal-bearing rocks are in situ. It is known from the papers of various authors that diverse layers of fossiliferous bands contain diverse assemblages of macrofossils. A succesion of these assemblages was generally considered as a result of a progressive marine ingression followed by a regression, or of a shallowing and freshening brought about by the filling up of the sedimentation space. If that had actually been the case, then in the layers in which a purely marine macrofauna appears even marine foraminifera and other microfauna should appear.

Layers with a rich macrofauna from diverse marine-fauna bands were sampled. The result was negative. No foraminifera were found.

The negative result was not considered to be a proof of the non-existence of foraminifera in the Carboniferous in the Ostrava-Karviná coal district. The possibility of the allochthoneity of organic remains and the possibility of the sorting into diverse layers in the course of redeposition were taken into consideration. Therefore, the through-going sampling even of the layers of the bands without any traces of a macrofauna was proceeded to. Promising groups of beds, too, where no fauna had as yet been found were also sampled. This way of sampling was successful.

DISINTEGRATION OF SAMPLES

The samples chosen for the microfaunal investigation were successfully disintegrated in the following way:

1. Breaking up of the sample into pieces with the maximum size of round 5 cm.
2. One-week's dipping of the broken sample into water or into a weak solution of Glauber salt.
3. Sevenfold freezing up of the sample down to a temperature of —30°C, alternating with thawing, or with boiling, if necessary.
4. Careful loosening of resistant pieces of the sample with a press.
5. Normal washing.

THE CHARACTER OF BANDS WITH A MARINE FAUNA

Bands and layers with a marine fauna have as yet been found only in the Ostrava beds in all their zones: in the Petřkovice, Hrušov, Jaklovec and Poruba zones. No marine-fauna band has been found for the present in the Karviná beds, which overlie the Ostrava beds.

The following description registers the general character of the marine-fauna bands of the Ostrava beds beginning with the lowermost, Štúr's band, and terminating in the uppermost, Gaebler's band. In order to make the description as brief as possible, it was necessary to register only the results of the processes of fossilization, and the like ("... the ostracod carapaces are uncalcareous ...", etc.).

The Petřkovice Zone

Štúr's marine band

This band is now inaccessible. V. Šusta (1928) records a fairly rich fauna from this band.

The Theodor faunal band

Only undeterminable spherical and subspherical pyritic casts, a pyritic cast of an ostracod and an argillaceous infilling of a scaphopod have been found in mine Lidice, 4th gallery, S.W. cross-cut. A quartz wind-worn grain has been found in detritus.

In mine Urx twenty samples have been taken from the roof of Bohdan (= Theodor) seam in the 6th gallery, main cross-cut. Petrified (partially carbonized, partially pyritized) plant fragments with undeformed cellulae have been found directly above the seam. Two samples taken higher up are barren. Imprints of plant stalks and many angular, sub-angular and rounded quartz grains, more or less polished in a water environment as well as quartz grains with the worn-off limonitic coating have been found in the claystones from three samples taken at a distance of 3-5 m. from the seam. At a distance of 7 m. from the seam a small fauna suddenly appears. The fossils occur as far up as a level of 15 m. from the seam, with the exception of some isolated barren horizons. Marine species appear from the base up to the roof. *The fossilization is diverse and is worth mentioning, as it elucidates the mode of the origin of this faunal band.* All bivalve shells are complete (of course, only tiny and immature specimens remain preserved after washing). All the infillings of the shells of these specimens differ from the matrix; they are siliceous or very rarely pyritic. Specimens with yellow-white infillings, with ochre-brown infillings and with pigmented black-gray infillings sometimes occur together in one and the same sample. A black-gray claystone forms the matrix. It often happens that only the casts of shells are preserved; but even preserved shells and their fragments appear here and there, They are silicified for the most part. It is only very rarely (at some levels) that some of them

are still slightly calcareous. Gastropods, pelecypods and ostracods appear commonly, while scaphopods are more rare. Crinoids have been found only in a single layer (subpentagonal columnals, strongly pigmented, slightly calcareous), without any accompanying fauna. As to this find, it is necessary to mention that it is not feasible for purely marine organisms, such as crinoids are, to live in an environment in which other fauna would not prosper. One of the samples contains, in addition to the fauna, undeformed wood tissue similar both in texture and fossilization to that which has been found directly above the seam. The faunal band terminates in a thin layer containing small pyritic, more or less spherical casts, quite similar to those found in mine Lidice. It is not out of the question that they are remains of radiolaria.

The Leonard (= Albert) faunal band

In mine Urx, 6/7th gallery, the roof has been uncovered up to a height of 4 m. Two thinner layers (30 cm. and 17 cm.) of claystone lie above the seam. The samples from these layers are barren. These layers are followed upwards by claystones with a single bedding plane at a height of 149 cm. above the seam. Of the samples taken from these claystones only the samples from the level of 1.65-2 m. and that of 2.40 m. above the seam have afforded a small fauna. Casts of the fossils, most frequently pyritic, rarely siliceous, invariably appear. *Some of the siliceous infillings are whitish, others are yellowish, while still others are black-gray pigmented.* Casts of planispiral and trochospiral gastropods and very rarely of ostracods and scaphopods have been found. Pyritized pieces of wood, spherical pyritic infillings (of radiolarias?) and quartz grains with traces of polishing in a water environment appear rarely.

Another profile has been sampled in mine Urx, 5th gallery, 1st div.—South. The seam passes into the roof through coal shale containing several claystone layers. Samples have been taken both from various levels of this transition and from the overlying claystones up to a height of 1 m. above the seam. The fauna has been found only in the sample taken 5 cm. above the seam (a greater number of spherical pyritic casts, a trochospiral cast of the cavity of a gastropod).

Sampling has also been done in mine Urx, 5th gallery, 2nd div.—North up to a height of 2.40 m. above the seam. Faunal remains (pyritic casts, one of a complete pelecypod, the other spherical) appear only at a height of 30 cm. above the seam.

In mine Odra eleven samples have been taken from the roof of seam Leonard in the air-course in the 4th gallery up to a height of 1.50 m. above the seam. All the samples are barren. Pyrit is frequent in the wash-residues, just as it is in those of the samples taken in mine Urx.

The Leonard band strikingly differs from the Theodor band in fossilization. *It is invariably only imprints and casts of shells (pyritic for the most part), but no remnants of shells that have so far been found in the Leonard band.*

The faunal band below seam Viléma

This band is inaccessible at present.

The Bruno faunal band

According to V. Šusta (1928), two bands containing a marine fauna occur above seam Bruno. The roof of this seam has been sampled in mine Stalin II, 3rd gallery, main cross-cut, No. 71, ∅ 1058 m. No small fauna has been found.

Sampling has also been done in mine Stalin II, 3rd gallery, main cross-cut, No. 71, at ∅ 1040 m. above the seam which has been determined as seam Pavel, but is probably identical with seam Bruno. Five samples have been taken. The lowermost sample contains three argillaceous casts of planispiral gastropods (*Bellerophon s. l.*) with tiny remnants of

shells inside the casts as well as four spherical pyritic casts (of radiolarias?). The wash-residue of the second sample contains only an undeterminable siliceous cast of a fossil. A siliceous cast of a complete smooth ostracod has been found in the third sample. The fourth sample is without any fauna. In the fifth, the uppermost sample, an argillaceous cast of a planispiral gastropod has been found.

Marine faunal remains have also been met with in mine Vít. Únor, 8th gallery, east cross-cut, Ø 1149 m. above the seam that has been determined as seam Pavel, but is probably identical with the Bruno seam. An undeterminable remnant (of a fish ossicle?) has been encountered close above the seam. The sample of varved shale at a height of 20 cm. above the seam is without any fauna. At a height of 50 cm. above the seam, an argillaceous cast of a complete ostracod has been found. The samples at heights of 80 cm., 1 m. and 2 m. above the seam are without any fauna. The sample at a height of 4 m. above the seam contains a siliceous cast of a small gastropod.

The band below the Otakar seam

A new band containing a marine fauna has been found in mine Stalin, 3rd gallery, main cross-cut No. 71, below the seam considered to be the Otakar seam. It appears at Ø 715 m. and again at Ø 702 m.

Four samples were taken at Ø 715 m. The lowermost sample contains two argillaceous infillings of scaphopods and three siliceous infillings of smooth ostracods. The second sample from a higher level is without any fauna. The third sample contains an argillaceous cast of a scaphopod and pieces of pyritized wood without traces of deformations. The uppermost sample contains an argillaceous cast of scaphopod, two siliceous infillings of smooth ostracods and an angular, irregularly limited pyritic stick.

Three samples were also taken at Ø 702 m. in the same faunal band. The lowermost sample contains only an argillaceous infilling of a scaphopod. The sample taken higher up contains a similar infilling together with a siliceous cast of the cavity of a complete smooth ostracod and with irregularly limited pyritic sticks. The uppermost sample contains a pyritic infilling of a scaphopod, three siliceous infillings of cavities of complete ostracods and several silicified fragments of relatively thick valves of pelecypods.

The Nanetta (= Otakar = Prokop) faunal bands

General character of the lower marine-fauna band (Nanetta I):

In mine Stachanov, the roof of seam Otakar (= Nanetta) was sampled in the 7th gallery, north-east cross-cut. A fauna appears (with the exception of barren layers) close above the seam and continues over a distance of 100 m.

Samples were taken at distances of 0 m., 2 m., 5 m., 10 m., 15 m., 50 m., 90 m., 100 m. from the seam (the levels with a fauna are underlined). Small pyritic faunal casts and subangular quartz grains polished in a water environment as well as rare quartz grains having limonitic coatings were found close above the seam (a cast of a pelecypod coming from a complete specimen). The sample taken at a distance of 2 m. from the seam is barren and contains only quartz grains polished in a water environment. Pyritic casts of complete pelecypods and ostracods together with pyritic casts of gastropods and of undeterminable fossils were found at distances of 5 m. and 10 m. from the seam. In addition to pyritic casts of ostracods siliceous ones also appear. The samples taken at greater heights are barren. At distances of 90 m. and 100 m. from the seam, only siliceous casts of complete ostracods were encountered.

Sampling was also done in mine Stachanov, 7th gallery, communication cross-cut. No faunal remains (with the exception of a fragment of yellowish quartz—a remnant of a cast?) have been found close above seam Otakar (Nanetta). The wash-residue contains polished quartz grains. Unquestionably faunal remains have been found only in the samples taken at distances of 8 m., 10 m., 11 m., 14 m., 17 m., 18 m., and of 20 m. The casts of pelecypods and ostracods (all of complete specimens) are most frequent; conical, stick-like and

spherical casts (remnants of scaphopods and of undeterminable fossils) are rare. The casts of pelecypods and ostracods are mostly pyritic, rarely siliceous.

In mine Vít. Únor, 8th gallery, east cross-cut, samples were taken from the roof of seam Otakar (= Nanetta) at Ø 1208 m. Only some macrospores have been found close above the seam. The further samples taken at greater heights are barren. Faunal remains appear in the samples taken at heights of 1.5 m., 2 m., and 5 m. above the seam. They are pyritic casts of cavities of planispiral gastropods, scaphopods, of complete pelecypods, and a siliceous cast of the cavity of a complete ostracod.

In mine Stalin II, 3rd gallery, main cross-cut 71, samples were taken from the roof of seam Otakar (= Nanetta) at Ø 875 m. No fauna was found close above the seam. It only began to appear as high up as Ø 880 m. and was found in three samples. The lowermost sample contained three pyritic casts of gastropods and a siliceous one. One of the pyritic casts enclosed silicified remnants of the inner part of the shell. A siliceous cast of a complete smooth ostracod was also met with. The sample taken higher up contained only argillaceous metasomatosis of the shell of a scaphopod. The uppermost sample contained only an argillaceous cast of a gastropod.

Another locality was sampled in mine Šverma, 6th gallery, main cross-cut. Samples were taken close above seam Prokop (= Nanetta) and at levels of 30 cm., 70 cm., 1 m., 1.40 m., 1.80 m., 2.40 m., 2.80 m., 3.30 m., 3.80 m., 4.40 m., and 4.80 m. above the seam (faunal levels are underlined). The faunal content is very poor and consists only of pyritic casts of planispiral gastropods, of complete pelecypods and of scaphopods There was only a single siliceous cast of a scaphopod found among the others. Wood remnants without traces of deformation, mostly completely pyritized, appear at some faunal, as well as barren, levels. Undeformed limonitized wood remnants having a slight proportion of carbonized wood parts appear only at a level of 4.40 m. above the seam. It is quite rarely that spherical pyritic casts (of radiolarias?) appear. Quartz grains worn-off to various degrees and later polished in a water environment are in places rather abundant in claystones.

Pyritization is as strong in the Nanetta I faunal band as in the Leonard band, if not stronger. Pyritic casts of cavities of fossils are frequent. Siliceous casts accompany them only rarely and in a very small number. *It is surely interesting that usually only ostracods have siliceous infillings.* The shells have been leached out and a remnant of a valve has been found only in a single case. In this respect, too, faunal band Nanetta I resembles the Leonard band.

General character of the upper marine-fauna band (Nanetta II):

The other (upper) band of seam Nanetta (Nanetta II) was sampled in mine Stalin II, 3rd gallery, main cross-cut 71, Ø 940 m.

The sample taken at a lower level contains a complete ostracod with the silicified carapace and siliceous infilling. The sample taken higher up has supplied only a single pyritic infilling of a small pelecypod. A single stick-like pyritic infilling has been encountered at the uppermost level.

Further samples from faunal band Nanetta II were taken in mine Šverma, 6th gallery, main cross-cut. The sample from the wall of the cross-cut contains a siliceous cast of a complete smooth ostracod and some tubes besides some undeterminable fragments of brown siliceous casts. The samples from the material removed by digging have supplied further information on the fauna and its state. They contain some imprints bearing decalcified remnants of pelecypod valves, pyritic and argillaceous casts of scaphopods, rarely with decalcified shell remnants, and a pyritic infilling of a gastropod. One of the samples contains both strongly pigmented and light-yellow siliceous casts of complete ostracods and of gastropods together with a single pyritic cast of an ostracod.

These statements show that pyritization is considerably less frequent in faunal band Nanetta II than it is in Nanetta I. The siliceous casts are pigmented to various degrees. Remnants of shells have been preserved more frequently than they are in band Nanetta I.

The Hrušov Zone

The Františka faunal bands

Sampling was done in mine Šalomoun, 8th gallery, West cross-cut. The samples from ØØ 738 m., 739 m., 740 m., 741 m. and 742 m. contain a small fauna consisting of pelecypods, ostracods, gastropods and of undeterminable remains. With the exception of the lowermost sample (Ø 738 m.), the shells and valves are preserved, but all of them are completely silicified, uncalcareous. With the exception of a single case, all the pelecypod shells and ostracod carapaces are complete. All the infillings are siliceous, except for some pyritic ones in the sample from Ø 738 m. A quartz grain with the limonitic coating has been found in the detritus from the Ø 740 m. sample. The level at Ø 743 m. in the same locality is barren. A small fauna appears again at Ø 745 m. and continues up to Ø 755 m. It is similar in its composition to that of the lower levels. Most of the thicker shells, however, have preserved their lime content, in the inner layer at least. Almost all the small and thin-walled forms are silicified. Large valves occur in the wash-residues only in fragments so that it is impossible to say whether they were separated. All the small pelecypods and ostracods are complete, with siliceous or pyritic infillings. At the uppermost level, some ostracods with bleached-out, calcareous carapaces appear together with specimens having silicified and translucent carapaces and infillings.

The Františka band in mine Šalomoun consists, as seen from the description, of two divisions which differ in fossilization and are separated by a barren layer. In other words, two bands have developed here.

The Františka faunal bands were also sampled in mine Bezruč, 12th gallery, North main cross-cut. The fauna is richer both in species and individuals than that from mine Šalomoun. Fragments are all that is left of larger valves in the wash-residues so that it is impossible to say in what state they came to rest. All the small specimens of pelecypods, ostracods and of brachiopods are complete, predominantly with siliceous, rarely with pyritic infillings.

Three bands separated by barren layers appear in the cross-section. In the lowermost band, from Ø 429 m. to Ø 426 m., the silicification of the fauna is the strongest and it is only rarely that shells and valves with traces of lime occur. An admixture of fossils having pyritic infillings (some pelecypods and scaphopods) only appears as high up as the upper part of the lower band, from Ø 427 m. upwards. From this level upwards also ostracods begin to appear. The faunal content of the lower band consists of ostracods, pelecypods, gastropods (planispiral and trochospiral forms) and of scaphopods.

The sample taken at Ø 425 m. is barren. The layer from which this sample was taken underlies the middle, the most fossiliferous band (ØØ 424-412 m.). It contains frequent remains of pelecypods. Remains of gastropods, scaphopods and ostracods appear more rarely. The faunal remains are less silicified than those of the lower band. It is rather frequent that *not only the shells but also their pyritic infillings (their limy admixtures) are calcareous. The claystone enclosing the fossils, however, is uncalcareous and a great number of fossils have siliceous infillings.*

Layers without any fauna as well as layers containing a scarce fauna appear between ØØ 411 m. and 404 m. Worn-off quartz-grains with traces of polishing in a water environment sporadically appear in the claystones in this band; pyritized undeformed pieces of wood appear in the barren layer at Ø 409 m. Faunal remains are very scarce (two complete small pelecypods, fragments of larger valves and remains of scaphopods); the remains found are silicified.

Further twenty six samples from the Františka bands were taken in mine Bezruč, 5th gallery, main cross-cut. A purely marine fauna has been found close above the seam. It consists of representatives of brachiopods and pelecypods. The individuals are complete, the shells are well preserved and have maintained their lime contents. At a level of about 0.5 m. above the seam remnants of valves of fresh-water pelecypods occur together with complete shells of small marine pelecypods having siliceous infillings and together with shells of bellerophontid gastropods. The shells are mostly preserved, the thick ones being partially silicified, the thin ones completely so. A uniform small fauna in which pelecypods strikingly predominate appears higher up. The pelecypods are accompanied by scarce

gastropods (planispiral and trochospiral forms). All the shells of small and immature pelecypods are complete with siliceous infillings of cavities. The thick shells are partially, the thin ones completely silicified. A pyritic infilling has been found only in a single case. A new faunal change appears at a height of 1 m. above the seam. In addition to pelecypods and gastropods also silicified remnants of undeformed wood tissues appear at this level, while remains of fresh-water pelecypods together with marine pelecypods and gastropods (trochospiral and planispiral forms) appear at a higher level. The remnants of shells of marine pelecypods are complete; the infillings are siliceous. Some quartz grains, which occur rather frequently in the claystone, are only wind-worn, while others are polished in a water environment. Several layers with sorted material occur up to a height of 2 m. above the seam. Some of them contain a great number of small complete pelecypods together with small gastropods (trochospiral and planispiral forms) and rare ostracods, while other layers bear almost exclusively remains of larger pelecypods in association with larger planispiral gastropods. In one of the layers the small fauna is missing completely and only larger valves appear. The band terminates in a layer containing small pelecypods, gastropods and remains of scaphopods. Throughout the band the shells of small pelecypods are completely silicified, thicker valves, however, still partially maintain their lime contents. All the small pelecypods are compete.

A barren layer lies higher up. It is followed upwards by layers containing remains (imprints) of fresh-water pelecypods together with fragments of valves of marine pelecypods, of trochospiral and planispiral gastropods (*Bellerophon s. l.*), of scaphopods and of tentaculites. One of the layers (middle) bears even remnants of undeformed pyritized pieces of wood with carbonized bark. Remnants of undeformed wood tissues, unpyritized, but silicified, with carbonized bark portions have been found in another of the layers. Numerous small and large pelecypods as well as scarce scaphopods and gastropods (planispiral, rarely trochospiral forms) appear at a height of 2.50-5.70 m. above the seam. Only thin-walled shells are completely silicified. The infillings of shells are siliceous.

The described vertical section across the Františka bands in mine Bezruč is very interesting in containing occasional mixtures of fresh-water, marine and terrestrial faunas and floras. Pelecypods entirely predominate. The other organisms are subordinate. The scarceness of ostracods is surprising.

An experimental cross-cut in mine Václav, 6th gallery, has also been sampled. Seven samples were taken between ØØ 1920-1938 m. A spherical pyritic cast was found at Ø 1925 m. No other traces of a fauna have been found.

Samples were also taken in mine Jindřich, 8th gallery, west cross-cut between seams Olga and Františka. No fauna has been found.

The Františka faunal bands strikingly differ in fossilization from faunal bands Nanetta, Bruno and Leonard. Even when valves and shells are sometimes completely decalcified, nevertheless they are often preserved. It is surprising that no columnals of crinoids have been found in the Františka faunal bands even at levels and in the places with a very rich fauna. Nor were any foraminifera found.

Regional differences in the character of the Františka faunal bands are very instructive. *Mixtures of fresh-water and marine faunas appear only over a small area. It is only marine fauna, if any fauna appears at all, that occurs anywhere else. Mixtures of various fossilized faunal remains occur occasionally. The predominant mode of fossilization is diverse in diverse bands.*

The Roland faunal bands

The middle part of the Hrušov zone is formed of a whole series of cyclothems the correlation of which is unreliable. From these layers only a single, only locally and slightly developed band above seam Roland (in mine Šalomoun below the seam) has been so far referred to. Because of these circumstances, the middle part of the Hrušov zone was more extensively sampled. Samples were taken from the upper parts of various cyclothems, from the levels that were at least somewhat promising.

Several faunal bands have been found in the cyclothems in the middle part of the Hrušov zone.

The faunal band developed above seam Roland rarely bears complete carapaces of ostracods with smooth surfaces. In mine Jeremenko, 7th gallery, north-east part of the main cross-cut, Ø 337 m., remains of fresh-water pelecypods have been encountered at a height of 10-30 cm. above seam Roland. They have not been found at other localities. Terebelloid tubes most frequently appear in the fauna. They have, however, been encountered at several levels of the Hrušov zone between seams Václav and Flora.

The faunal layers with a sparse (mixed and fresh-water) fauna are developed only locally and appear both below seam Roland and in its roof as well as in superimposed cyclothems. Therefore, their correlation is difficult. The faunal finds may contribute to the identification of the middle Hrušov beds. But they cannot be used for the identification of individual seams.

It is worth mentioning that faunal bands of similar character also appear in the middle part of the Poruba zone. Terebelloid tubes have also been encountered there.

The Pipin faunal band

Samples were taken in mine Jeremenko in the first cross-cut below the sixth gallery. At a height of 30 cm. above the seam there is a thin claystone layer in which macrofauna has been found. The claystone, however, is without any small fauna.

Samples were also taken in mine Jeremenko in the north-east part of the main cross-cut in the seventh gallery. Two spherical pyritic casts have been met with close above the seam. An undeterminable uncalcareous fragment of a fossil has been found at a height of 15 cm. above the seam. Fragments of terebelloid tubes appear at heights of 20-25 cm. Such tubes have also been found in four further samples taken higher up, up to a height of 70 cm. above the seam. The remaining three samples taken at heights of 80-180 cm. above the seam are barren.

The Pipin band belongs, in its character, to a group of bands developed both below and above seam Roland.

The Enna faunal bands

These bands appear in "seamless" beds, in a sequence of strata containing only thin seams. Some of them already appear as low down as above the Flora seam; some others only appear as high up as above seam Enna. V. Šusta unites both of them under the name of "the Enna bands" because the identification of seams Flora and Enna is not always reliable. For the same reason, the sections across all superimposed faunal bands are here described.

A very detailed sampling was done in mine Zárubek, 10th gallery, side-cross-cut No. 4, from the base of twin-seam Flora up to the roof of seam Enna.

The parting in twin-seam Flora bears stigmarian appendices. An amorphous opal was found in the middle part of this parting. Pyritized (not carbonized) fragments of wood tissue and subangular quartz grains were met with in the upper part of this parting.

Twenty eight samples were taken between seams Flora and Enna. A fauna appears only at the levels at a distance of 4.50 m. from the seam (a fragment of a fish tooth) and at a distance of 11.75 m. (a fragment of a silicified valve).

Columnals of the crinoids appear in great abundance close above the Enna seam. (These exacting marine organisms cannot stand brackish water.) *Some of them are completely pyritized, others bear traces of weathering* (they are whitish or rusty with limonite, porous, completely silicified or still slightly calcareous). Apart from these columnals, no other faunal remains have been found so that even this circumstance suggests that the fossils are not in the original place. At a height of 25 cm. above the seam, there are no more traces of crinoids. Nothing else has been found but a complete smooth ostracod with the silicified carapace and siliceous infilling, a siliceous conical cast and fragments of a conical fish tooth. The sample from a level of 1 m. above the seam is barren. The sample from a level of 1.50 m. above the seam contains a crinoid columnal that is still slightly calcareous, quite differently fossilized from the columnals found close above the seam (it is yellowish, non-porous). A complete ostracod with the silicified carapace and siliceous

infilling as well as an undeterminable remnant, perhaps of a crinoid, were found at a level of 2 m. above the seam. The level of 2.50 m. above the seam is barren. It is followed, upwards, by a thick band (3-9.50 m.) rich in fossils and divisible according to fossilization into two divisions. The lower division (3-6 m.) bears very abundant pyritic sticks. Most probably, they are for the most part infillings of tubes of organisms (worms?). A proportion of them may also be pyritic metasomatoses of crinoid columnals. Pyritic casts of the cavities of complete pelecypods and of complete ostracods as well as siliceous infillings of complete ostracods, and some undeterminable fossils rarely appear together with the afore-mentioned pyritic sticks. A siliceous infilling of a gastropod has also been encountered. Of the foraminifera, nothing but two fragments have been found (*Rhabdammina* sp. and *Hyperammina* sp.). In the upper division of the band (6.50-9.50 m.), pyritization strikingly yields to other modes of preservation of the fossils. An echinoid spine with preserved lime content and fragments of undeformed carbonized wood the tracheids of which are filled up with pyrite were found directly in the base of this division. Crinoid columnals with preserved lime contents, siliceous infillings of undeterminable remains, two fragments of foraminifera beyond precise identification (*Hyperammina* sp.), and fragments of wood were found at a level of 7.50 m. above the seam. The afore-mentioned fragments of wood are somewhat more strongly pyritized than those found lower down so that not only the cavities but also some parts of the cellular walls have been attacked. Complete ostracods with calcareous carapaces and siliceous or pyritic infillings as well as undeterminable fragments of fossils, some of them being calcareous, some others silicified, appear higher up (8-9.50 m.). The level of 10 m. above the seam is barren. Two complete ostracods with calcareous carapaces and siliceous infillings have appeared at a level of 10.50 m. above the seam. The level of 11 m. is also barren. A complete ostracod with the calcareous carapace and siliceous infilling has been found at a level of 11.50 m. above the seam. No small fauna has been encountered higher up.

The beds overlying seams Flora and Enna have also been sampled in mine Alexander, 5th gallery, south-east cross-cut.

No small fauna has been found in the sediments between seams Flora and Enna.

A layer containing abundant crinoid columnals appears (just as in mine Zárubek) close above the Enna seam, near Ø 443 m. They are completely missing near Ø 442 m. The columnals bear traces of weathering and are slightly limonitized, porous, decalcified. But on the contrary to the locality in mine Zárubek, other faunal remains, i. e., foraminifera (*Hyperammina* sp.), fish scales as well as siliceous and argillaceous casts of undeterminable remains of rare fauna appear together with the columnals. Pyritized crinoid columnals have not bee found.

The barren layer near Ø 331 m. may be correlated with the barren layer lying 1 m. above seam Enna in mine Zárubek.

This layer is overlain by fossiliferous sediments between ØØ 439.20-431.80 m. Only a siliceous cast of a complete ostracod and two siliceous casts of undeterminable remnants of fossils have been found at the base of these sediments (Ø 439.20 m.). The upper part of the fossiliferous sediments may be divided (just as in mine Zárubek) into two divisions. The lower division (ØØ 438-436 m.) bears numerous *pyritic sticks* (infillings of worm tubes?), *which are associated with columnals of the crinoids* at some levels (Ø 436.50 m. and Ø 436 m.). *The latter are attacked by weathering,* are porous, slightly limonitized, sometimes with a very slight content of lime. The crinoid columnals are associated with complete pelecypods and ostracods having pyritic and siliceous infillings of the cavities and with fragments of undeterminable fossils. Pyritization yields strikingly to other modes of fossilization in the upper division (ØØ 435.20-431.80 m.) as it does in mine Zárubek. All the ostracods and pelecypods are complete, often with preserved calcareous shells, with clear siliceous (rarely also calcareous) infillings of the cavities. The ostracods and pelecypods are rarely associated with gastropods. Crinoid columnals with the lime contents preserved have also been met with at a level near Ø 434.50 m. Calcareous and argillaceous infillings of some fossils occur sporadically. *As to the presence of calcareous infillings, it is necessary to emphasize that the fossils with these infillings are embedded in an uncalcareous* claystone. These statements perhaps suffice for us to understand that mixtures of remains of the organisms which fossilized in diverse environments have accumulated in this band.

Further faunal bands have been found between ØØ 240-207.50 m. There is no correlating these with those found in mine Zárubek.

Only complete smooth ostracods with preserved, but entirely sicilified carapaces and siliceous infillings of the cavities have been found at levels near Ø 240 m. and Ø 239 m.

The layers near Ø 238 m. and Ø 237.80 m. are barren.

Variously fossilized remains of organisms appear in the layers near ØØ 236.50 m., 235.20 m. and 234.50 m. Only two complete limonitized (brown-red) ostracods, silificied, with translucent uncalcareous infillings have been found at Ø 236.50 m. A complete ostracod fossilized in a similar way, a silificied, non-limonitized ostracod with the siliceous infilling of a tube-like cavity and a pyritic cast of the cavity of a complete small pelecypod have been met with at Ø 235.20 m. *The mixture of variously fossilized remains is most conspicuous* at Ø 234.50 m. *Pyritic sticks (infillings of worm-cavities?) are associated with crinoid columnals that are strongly limonitized (brown-red), porous, entirely decalcified as well as with columnals that are non-limonitized, gray-white, porous, silicified.* A complete silicified ostracod with the siliceous infilling of cavity has also been found.

The samples from the layers at Ø 234 m. and Ø 232 m. are barren.

A fauna has been found again in the samples from the band between Ø 230 m. and Ø 223 m. If the remains of organisms in the lower fossiliferous layers between Ø 240 m. and Ø 234.50 m. have been completely silicified, at least some of the remains in the band between Ø 230 m. and Ø 223 m. have maintained their lime contents. The crinoid columnals are most conspicuous among the faunal remains. They are more or less attacked by weathering, limonitized, porous, uncalcareous or only slightly calcareous. The remains of complete ostracods are rather abundant and through-going. Their carapaces sometimes maintain their lime contents. The infillings of their cavities are most often siliceous, rarely pyritic. An echinoid spine has been found at the lowermost level (Ø 230 m.); fragments of larger valves with preserved lime contents have been encountered at two uppermost levels (Ø 224 m. and Ø 223 m.).

The layers at Ø 219.50 m.-Ø 213.20 m. are barren.

A new fossiliferous band appears higher up between Ø 213 m. and Ø 211 m. This band is characterized by a greater frequency of gastropods and by pyritization of many fossils. Pyritic and argillaceous casts only rarely bear remnants of silicified valves (larger gastropods only). The pyritic metasomatosis of the shell of a gastropod found at a level near Ø 211 m. is also conspicuous.

The layer at Ø 209 m. is barren.

Only pyritico-argillaceous infillings of the cavities of a few larger gastropods have been found in the layer near Ø 207.50 m.

The sediments deposited higher up are barren. They terminate on the fault near Ø 182 m.

Above the fault, a very rich fossiliferous band appears between Ø 176 m. and Ø 157 m. above the barren sediments. This band greatly resembles in some features the band overlying the Enna seam, but differs from it in other features. The presence of pyritized crinoid columnals (the basal level of the band at Ø 176 m.) and a considerable pyritization of many other fossils at the lower and the uppermost levels are joint features; the presence of brachiopods, gastropods and cephalopods, and at one of the levels (Ø 182 m.) also of semi-calcareous foraminifers (*Hemigordius*) is a distinguishing feature. All the shells of ostracods, pelecypods and brachiopods are complete just as they are in other faunal bands (of course, it is only smaller or immature forms that are open to observation in wash-residues). Striking mixtures of variously fossilized remains appear at certain levels. The lime contents of the shells are preserved only rarely, chiefly in thicker valves. At some levels, the valves have been completely leached out and all that remains are only pyritic and siliceous casts of the cavities, and imprints. The crinoid columnals at some levels are whitish, calcareous, but without traces of weathering.

The roof of the fossiliferous band described (Ø 135 m.-Ø 120.50 m.) is barren.

The roof of the Enna seam was also sampled in mine Šalomoun, 6th gallery, west cross-cut, between Ø 158 m. and Ø 108 m.

The roof of the Enna seam (Ø 158 m.-Ø 126 m.) is without any fauna (pyritized pieces of wood without traces of deformation have been found near Ø 126 m.).

A fragment of foraminifer (*Hyperammina* sp.) in association with casts of the scaphopods, with a silicified complete ostracod, with a slightly limonitized crinoid columnal and with a pyritic stick (infilling of a worm cavity?) have been encountered at Ø 125.50 m. in the base of the lower fossiliferous band. The remaining portion of the lower fossiliferous

band (Ø 125 m.-Ø 122 m.) bears very abundant pyritic sticks together with rare gastropods, scaphopods and with complete ostracods and pelecypods. The shells are for the most part completely leached out. Their remnants are silicified. Pyritic or siliceous casts of cavities are mostly all that is left of a fauna. Therefore, the find of a complete ostracod with the calcareous carapace in a separate layer near Ø 118 m. is worth noticing.

The described band may be correlated with the band which lies in mine Zárubek 3-9.50 m. above the Enna seam. It is typical that some layers with sorted fauna which appear in mine Zárubek (e. g. layers stuffed with crinoid columnals) have not developed in the area of mine Šalomoun.

The roofs of seams Enna and Flora were also sampled in the experimental cross-cut in the 6th gallery in mine Václav.

Between seams Enna and Flora, a small fauna has been found only at Ø 1598 m. (three siliceous casts of complete ostracods).

Almost the whole roof of the Enna seam is barren. A fauna has been found only in the layers near Ø 1527 m. (a calcareous cast of a scaphopod cavity), near Ø 1521 m. (a siliceous cast of a complete ostracod), and near Ø 1497 m. (very abundant pyritic sticks—infillings of worm cavities?).

It is evident from these finds that some of the layers containing pyritic sticks (which are abundant in several layers in mines Zárubek, Alexander and Šalomoun) extend into the area of mine Václav.

The Jaklovec Zone

A greater number of fresh-water-fauna bands appear in the lower and upper parts of the sequence of strata in the Jaklovec zone. Some time ago, a marine-fauna band was found between the lower and the upper group of the fresh-water-fauna bands. In searching for this band and its fauna, a series of prospection samples were taken from various promising levels. A marine microfauna has nowhere been found. Some of the fresh-water-fauna bands bear representatives of the *Thecamoebina* (the roof of the 5th Jaklovec seam in mine P. Cingr II; the roofs of seams 13 b and 12 P. in mine Ludvík).

The Barbora faunal bands

The Jaklovec beds terminate, in the new stratigraphical conception, in "seamless" beds, which underlie the Zámek conglomerates. These beds contain fossiliferous bands usually designated as the Barbora bands.

The most complete profile across the fossiliferous Barbora bands has been acquired in mine Václav, 4th gallery, north-west cross-cut.

The thecamoebina and remains of fresh-water pelecypods appear directly above the 10 P. seam (= seam Barbora). Separated layers with thecamoebina and fresh-water pelecypods appear up to a height of 45 m. above the seam. They alternate with unfossiliferous layers. Calcareous faunal remains have been leached out completely and only imprints remain.

The beds lying at a height of 50-58.80 m. above the seam are composed of three sorts of sediment that alternate with one another: (1) claystones without any fauna; (2) claystones with imprints and silicified fragments of valves of fresh-water pelecypods; (3) claystones with silicified fragments of scaphopods.

At a height of 59 m., there is a sharp boundary between the layer with fresh-water pelecypods and the overlying layer with calcareous marine fauna remains (two calcareous fragments of scaphopods, a partially silicified complete carapace of an ostracod and a fish tooth have been found there). The layer at a height of 59 m. above the seam is a base of a group of separated layers in which calcareous remains of a purely marine fauna very different in fossilization most frequently appear. Such layers continue as far as a height of 109 m. above the seam. Their description follows:

59.60 m. above the seam: Without any fauna.
60 m. above the seam: Calcareous fragments of a larger pelecypod and of a scaphopod.
69.20 m. above the seam: Without any fauna.

69.30 m. above the seam: *A pentagonal crinoid columnal bleached out through weathering, with traces of coal matter on the surface. Fragments of valves of larger pelecypods (one of them with whitish patina, two coated with coal matter). All the remains are calcareous. The rock in which the fossils are embedded is a claystone without coal laminae or a seam.*

69.40 m. above the seam: A fish tooth. Calcareous and silicified fragments of valves of larger pelecypods, *some of them being limonitized, others bleached out* through weathering.

75 m., 85 m., 89 m., 100 m., 101 m. above the seam: Without any fauna.

109 m. above the seam: A great number of gastropods, crinoids and foraminifers. Rare pelecypods and ostracods. Bivalve shells complete. *Shells calcareous, partially silicified; infillings often siliceous, rarely pyritic. The fossils are embedded in a calcareous (!) claystone.*

111 m. above the seam: Without any fauna.

A new group of separated fossiliferous layers appears at heights of 117-152 m. above the seam. Siliceous casts of pelecypods and scaphopods appear almost exclusively. Especially the layer at a height of 147 m. above the seam is worth noticing. *It is formed of calcareous (!) claystone containing complete ostracod carapaces which are completely silicified.*

The sediments at heights of 153-173 m. above the seam are barren.

At a height of 176 m. above the seam there is a layer with abundant faunal remains. Crinoid columnals are abundant. They are often deformed, calcareous, bleached out or limonitized through weathering. The carapaces of ostracods are complete, silicified, with siliceous casts. Two siliceous casts of gastropods and a few fragments of valves of larger pelecypods have also been found. *With the exception of siliceous casts of gastropods, everything has been bleached out or limonitized through weathering to a varied extent. The sediment, however, in which the fossils are embedded does not bear any trace of weathering.*

The sediments at heights of 178.60-181.50 m. above the seam are without any fauna.

The uppermost fossiliferous band appears 184-186 m. above the seam. It bears siliceous casts of complete ostracods, pelecypods and gastropods and fish teeth. *A brown argillaceous cast of a scaphopod has also been found (the matrix is a gray-black claystone).* A calcareous valve of an ostracod has been encountered together with the fossils described.

No commentary is needed on this description of the Barbora bands. We have only to recall that the transition of fresh-water fauna into the marine is only seeming. The assemblages of variously fossilized remains speak about the genesis of the fossiliferous bands in a more eloquent way than anything else.

It was possible to take only a few samples from the Barbora bands in mine Václav, 6th gallery, cross-cut No. 4.

Only two samples could be taken from the lowermost band near Ø 302 m. Both of them contain ostracods in great abundance and numerous pelecypods. Of the gastropods, nothing but a single pyritic cast has been found. Of the crinoids, only a single columnal circular in cross-section has been met with. There are no traces of foraminifera and other fauna. The valves are mostly calcareous, some of them slightly silicified. The cavities are mostly filled up with pyrite; the rest of them has siliceous infillings.

It was possible to take two samples from a band lying higher up near Ø 320 m. Abundant crinoid columnals circular in cross-section appear at a lower level. *Some of the columnals are fossilized in a normal way* (non-porous, calcareous); *others are strikingly bleached out,* their porosity is maintained and the columnals are on the surfaces more or less enveloped with rusty limonitic coatings, which easily fall away. In addition to the crinoids, scarce pelecypods, gastropods and ostracods also appear at the lower level. The foraminifera are abundant. The faunal remains are mostly calcareous, some of them are partially silicified. The infillings are calcareous, siliceous or pyritic. The varied mode of fossilization of the remains is extremely conspicuous and shows that we have to do with a pseudoassociation. Neither foraminifera nor crinoids appear at a higher level. Ostracods and gastropods are fairly abundant. The total number of fossils is strikingly smaller than that at the lower level.

It was impossible to take any sample from the third Barbora band near Ø 358 m.

Two samples were taken from the fourth known marine fauna band near Ø 365 m. Only ostracods with calcareous carapeces and undeterminable infillings of larger fossils have been found.

Three samples were taken from the lower layers above the Barbora seam in mine P. Cingr II (= Michálka) in the 2nd gallery, north cross-cut. Two of them are barren. The third sample contains two thecamoebinas together with a brown limonitized stick, in places still slightly calcareous, which is a remnant of a crinoid columnal. This find is interesting. *It proves the presence of fresh-water organisms (thecamoebinas) in the lower layers above the Barbora seam in the area of mine P. Cingr II. The results of the examination of other localities (mine Trojice and others) show that the layers with a fresh-water or a mixed fauna are not of wide regional extents.*

It was possible to sample extensively the roof of the Barbora seam in mine Trojice, 2nd gallery, north cross-cut. On the whole, thirty samples were taken within the range from the Barbora seam up to a height of 32 m. above it.

The roof of the seam is barren. A fauna has only been found as high up as 8.50 m. above the seam. It is purely marine and consists of foraminifers, ostracods, gastropods, pelecypods and crinoids. The fragments of pelecypod valves and ostracods carapaces are calcareous; the ostracod infillings are siliceous. Of the gastropods, however, nothing but two siliceous infillings have been encountered. A crinoid columnal is silicified. *The joint occurrence of remains of varied fossilization points to their allochthoneity.*

The fauna continues up to a height of 19 m. above the seam. It varies in its composition and mixtures of variously fossilized remains appear. Of the gastropods, it is only siliceous infillings that appear (9 m., 12 m. above the seam), sometimes bearing remnants of valves with the lime content preserved (14 m., 18 m., 19 m. above the seam). At some levels we can find only ostracods with calcareous carapaces and siliceous infillings (15 m., 16 m., 18 m. above the seam), at other levels only ostracods with calcareous carapaces and pyritic infillings (19 m. above the seam), at some other levels only siliceous casts of ostracods (11 m., 12 m. above the seam), while at still other levels both the ostracods with pyritic infillings and those with siliceous ones appear together (10.50 m., 14 m. above the seam). *Separated valves of ostracods have been found only at two levels* (14 m., 15 m. above the seam). Imprints and calcareous fragments of pelecypod valves appear at levels of 10 m., 13 m., 14 m., 15 m., 17 m., 18 m. and 19 m. above the seam. Remains of scaphopods and limonitized, very poorly preserved remains of crinoids appear extremely scarcely. The ostracods entirely dominate in the fauna.

The samples from the layers at heights of 20-22 m. above the seam are barren.

A fauna appears again at a level of 23 m. above the seam (one calcareous cast of a complete ostracod and three complete pelecypods with calcareous valves).

The layers at heights of 24 m. and 25 m. above the seam are barren.

A fauna reappears in the bands lying at a height of 26-30 m. above the seam. In most of the layers of this band, ostracods entirely dominate over the remaining fauna, which is similar in its composition and modes of fossilization to that found in the band between 8.50 m. and 19 m.

All the beds deposited higher up than 30 m. above the seam are barren.

A series of samples were taken from the Barbora bands in mine Fučík II in the 5th gallery in the communication cross-cut between mines Fučík I and II.

It was possible to take only two samples from the lower band of the Barbora seam. Both of them contain only abundant ostracods with siliceous infillings and mostly with calcareous valves.

A series of samples were taken in the so-called second Barbora band. The ostracods entirely dominate in the fauna. They are usually complete, with calcareous carapaces, with siliceous, more rarely pyritic infillings. Of the other fauna, it is the gastropods (trochospiral and planispiral forms), pelecypods, very scarce fish teeth and stick-like excrements that appear. The shells are well preserved and despite of a certain amount of silicification the prevalent majority of them have maintained their lime contents. Bivalve shells are usually complete; the casts are siliceous, but pyritic casts are also rather frequent.

The so-called third Barbora band was also sampled. In this band there is an alternation of layers having a rich fauna with barren layers and with layers containing a poor fauna. The ostracods with calcareous carapaces and siliceous infillings dominate in the layers with a rich fauna. The gastropods are rare. *As in other localities, the gastropods are more strongly silicified than the other fauna. All that has most often remained of them are siliceous infillings. Strongly silicified shells or pyritic casts are scarce. The same applies to the scaphopods. The mode of their preservation is in strong contrast with the*

fossilization of ostracods. Pelecypods and extremely rare brachiopods and crinoids appear in the fauna in some layers. Foraminifera are scarce and have been encountered only in two layers. Stick-like excrements are also scarce. Bivalve shells are usually complete. The valves mostly have well preserved their lime contents, the casts, however, are usually siliceous. The layer in which three siliceous casts of ostracods have been found together with a limonitized cast of an ostracod and with a limonitized stick-like excrement is the most interesting among the layers with a poor fauna.

One may conclude that the faunal composition in the area of mine Fučík II strikingly resembles that in the area of mine Trojice.

Very interesting faunas have been supplied by samples from mine Fučík I, the aircourse from the 9th into the 10th seam above the 5th gallery. On the whole, twenty-eight samples have been taken. All of them (except for a single one) have supplied rich faunas. *If we compare these faunas with those from mine Fučík II, we can see a striking difference. Very abundant gastropods dominate over ostracods in many layers;* it is only in some layers that ostracods dominate over other forms. The other faunal remains appear only in quite a subordinate number besides the gastropods and ostracods. Only pelecypods, scaphopods and stick-like excrements appear in some abundance in some layers. Crinoid columnals are very scarce. *The fossiliziation is diverse and mixtures of variously fossilized remains are fairly frequent. So e. g. in the layer at a distance of 90 m. from point 712, limonitized ostracods appear together with those the carapaces of which are filled up with pyrite and together with those the carapaces of which are filled up with clear quartz.* The shells of faunal remains are mostly well preserved and have maintained their lime contents. The infillings are usually siliceous; in some layers pyritic infillings are rather frequent. *It is interesting that separated valves appear in some abundance besides complete ostracods in some layers, which is a rare case in the Ostrava beds. A new fine document of the allochthoneity of the fossils has been ascertained in a layer at a distance of 96 m. from point 712 (the gastropods with infillings formed of light claystone appear together with those with the infillings formed of dark claystone).*

As to the Barbora bands, one may conclude that they show conspicuous regional changes in the faunal composition, which are well accounted for by the regional sorting of material. The layers with a fresh-water and a mixed fauna have developed only locally. Gradual transitions from fresh-water faunas into marine have nowhere been observed. Many phenomena suggest that the fossils are not autochthonous.

The Poruba Zone

The Gabriela bands

The roof of seam Gabriela in mine Václav, 4th gallery, north-east cross-cut bears a macrofauna. The small fauna, however, is completely missing.

In the parallel cross-cut in the 4th gallery, fish remains (one tooth and undeterminable fragments), several imprints with silicified remnants of thin-walled valves, and two spherical pyritic casts (of radiolarias?) have been found close above the seam. The sediments deposited higher up are barren. It is only in the layer deposited as high up as 6 m. above the seam that two siliceous casts of small complete pelecypods and several calcareous fragments of a thick-walled valve have been found. The layer at a hight of 8.50 m. above the seam bears pyritic infillings of small complete pelecypods. The sediments deposited higher up are again barren.

Sampling was also done in mine Žofie, cross-cut 721. Very abundant spherical pyritic casts (of radiolarias?) and a scaphopod cast occur close above the seam; and spherical pyritic casts together with fragments of undeformed pyritized wood having some carbonized portions appear at a level of 20 cm. above the seam. The samples from levels of 40 cm. and 60 cm. above the seam are barren. Nothing but a spherical pyritic cast has been found at a height of 80 cm. above the seam. The samples from levels of 1 m. and 1.40 m. above the seam are without any fauna. Crinoid columnals, bleached out, decalcified or only slightly calcareous have been encountered in abundance at a height of 2 m. above the seam. The level of 3 m. above the seam is again without any fauna. A silicified scaphopod

shell and an imprint of an undeterminable fossil with the pyritic infilling have been found in the layer at a height of 4 m. above the seam.

Individual, isolated layers only of local extents and bearing faunal remains appear throughout the whole roof of seam Gabriela, as shown by the find of marine fauna in mine Žofie, cross-cut 72, at a level of 2.50 m. below seam Sec. Nothing but a single, slightly calcareous crinoid columnal was found in the sample from this level.

The Koksová (= Sec) band

The sample from the roof of seam Sec, mine Václav, 6th gallery, 4th cross-cut, contains abundant pelecypods, only two gastropods, several foraminifers and a smooth ostracod in addition to other undeterminable small faunal remains. The shells are calcareous, the infillings siliceous or argillaceous.

It was possible to sample almost a whole profile in the 4th gallery of mine Václav in the north-east cross-cut to the air-pit near ∅ 510 m. The roof of the seam up to a height of 150 cm. is without any fauna. The sample taken at a height of 350 cm. above the seam contains abundant pelecypods, gastropods and scaphopods, scarce crinoids, but no foraminifers. A similar fauna, but with abundant foraminifers, appears at a height of 360 cm. above the seam. The shells are calcareous, the infillings siliceous or argillaceous, rarely pyritic. At a level of 350 cm. above the seam, a proportion of the shells have a white patina.

A complete profile was sampled in the same mine in the 4th gallery in a parallel cross-cut. It is very interesting to note to what extent it differs in its general development from the foregoing profile. A fauna has been found above the seam already at a height of 0.50 m. (one pyritic and one siliceous cast of complete small pelecypods). A bleached-out, but calcareous scaphopod shell and a fragment of a valve fossilized in a similar way have been found together with a siliceous cast of a small pelecypod in the layers at distances of 1-2 m. from the seam. The layer at a height of 4 m. above the seam is barren. A disproportionately richer fauna appears in the layers at distances of 4-9 m. from the seam. The pelecypods appear in abundance. All the small pelecypods are complete. All that is often left of them, however, are siliceous infillings and extremely rarely even pyritic ones. These infillings bear here and there remnants of the valves that only sometimes maintain their lime contents. The fragments of larger and thicker valves are as a rule calcareous. Remains of the scaphopods also occur in some abundance. They are silicified, bleached-out valves, calcareous valves preserved in a normal way, and siliceous (at some levels also pyritic) casts. The gastropods are extremely rare. The same applies to crinoid columnals, which have preserved their lime contents. A single fish tooth has also been encountered. The foraminifers appear only at some levels (5 m., 7.5 m. above the seam). The occurrence of undeformed pyritized pieces of wood in the layers at heights of 7.5 m. and 8 m. above the seam is interesting.

Further samples were taken in mine Žofie, cross-cut 721. The roof of the seam up to a height of 1 m. is without any fauna (an interesting quartz grain with a white patina has been found close above the seam). A fish-ossicle remnant has been encountered at a level of 1 m. above the seam. A gastropod with the calcareous shell has been met with at a level of 1.5 m. above the seam, and a crinoid columnal strongly worn-off has been found at a level of 3 m. above the seam.

The Jindřich band

A series of samples were taken from the Jindřich band in mine Žofie, 7th gallery, in the cross-cut to seams Konrád—Gustav—Filip. The wash-residues of these samples are barren.

Other samples were taken in mine Václav, 4th gallery, north-north-east cross-cut. A conspicuous abundance of gastropods appear close above the seam and diminishes suddenly and strikingly at a height of about 40 cm. above the seam. A comparatively small number of small complete pelecypods appear in addition to the gastropods. Many gastropod shells

bear attached tests of foraminifera (*Apterrinella*). No other fossils have been ascertained for the present and so the whole fauna has a strikingly uniform character, such as has, in the case of such an abundance of specimens, been observed up to the present only in some facies and layers in other faunal bands, especially in some facies and layers of the Barbora bands. *Experiences show that such assemblages of fossils originated in sorting* so that pseudoassociations composed of remains of other organisms may be expected in adjacent areas.

All the fossils as well as their infillings are completely silicified, without traces of lime. It is only very rarely that some of the fossils are filled up with pyrite.

The fossils appear as high up as 1 m. above the seam. Then a barren sequence of strata follows, in which only in the layer deposited 10 m. above the seam a silicified complete ostracod and a siliceous cast (probably of a small pelecypod) have been found.

The Justin and Konrád bands

A variable number of nameless thinner seams occur in the section between seams Justin and Konrád. Some time ago two faunal bands (the lower one with a fresh-water and the upper one with a marine fauna) were found in this section. Only the marine-fauna band has been found in mine Žofie. In other mines no bands have been encountered between seams Justin and Konrád. Because of these circumstances, all promising layers in various localities have been sampled.

A marine fauna has been found above a nameless thin seam in mine Václav, 4th gallery, north-east cross-cut to the air-pit, Ø 566 m. It is relatively poor. It consists of complete pelecypods, gastropods and of complete smooth ostracods, all being fully silicified, uncalcareous, with siliceous infillings. Ovoid pyritic casts (of radiolarias?) are rather frequent.

Three samples were taken from the known marine-fauna band below seam Konrád in mine Žofie, cross-cut 721. The lowermost sample contains nine casts of scaphopods (eight siliceous, one pyritic) and a siliceous cast of a complete small pelecypod together with megaspores and compressed pyritized stems. The uppermost sample contains only a siliceous infilling of a complete pelecypod. The sample from the middle level is barren.

The results of earlier investigation and of the new prospection show that fossiliferous layers of local extents and importance occur at various levels between seams Justin and Konrád. The faunal content is usually poor and variable.

The roof of seam Konrád was sampled in mine Žofie, 7th gallery, cross-cut to seams Konrád—Gustav—Filip. Two layers with fauna have been found (13.8-15 m. from the seam, 56-57 m. from the seam). *Crinoid columnals (some of them limonitized and decalcified, others fossilized in a normal way and slightly calcareous)* and ostracods having either slightly calcareous or silicified carapaces have been found in the first layer. The other layer (56-57 m. from the seam) contains terebelloid tubes, such as appear in the bands of seams Roland and Pipin.

Lower Roemer's band

No fauna has been found.

Upper Roemer's band

Sampling was done in mine Žofie, cross-cut 710. The roof of the seam as high up as 120 cm. is without any fauna (megaspores appear close above the seam).

TABULAR SUMMARY OF THE OCCURRENCE, GENERAL COMPOSITION AND MODES OF PRESERVATION OF THE SMALL MARINE FAUNA

Zone	Faunal band	Locality	General composition of the small fauna	Mode of fossilization of the small fauna	Remarks	Outstanding features
The Poruba zone	Gaebler's band	Mine Žofie, cross-cuts 503/II, 710/I, 720/II, 700.	Foraminifers, spherical pyritic casts (of radiolarias?), trilobites, ostracods, brachiopods, pelecypods, tentaculites, gastropods (planispiral and trochospiral forms), scaphopods, cephalopods, cystoids, crinoids, echinoids, pyritic infillings of tubes (of worms?).	Shells dark ochrous, rarely limonitized or slightly bleached-out, well preserved, calcareous; infillings calcareous and pyritic; small bivalve shells complete.	Dasycladaceas.	The richest band in foraminifers and other fauna, faunistically most miscellaneous. Claystones calcareous. Fauna excellently preserved; shells non-silicified, calcareous. Pyritization rather frequent.
	Upper Roemer's band	Mine Žofie, cross-cut 710.	In the upper part only pelecypods; in the lower part pelecypods together with gastropods, ostracods, and with very rare scaphopods, crinoids and echinoids.	In the upper part everything silicified. In the lower part many shells calcareous, the infillings siliceous, rarely pyritic. Rarely limonitized and bleached-out shells. Small bivalve shells complete.	The band of two parts differing in the wealth of fauna and in fossilization.	Silicification slighter than in lower bands.
		Mine Žofie, cross-cut 720.	Gastropods and pelecypods.	Everything silicified except for some valves.	Only a part of the lower band developed.	
	Lower Roemer's band	Mine Žofie, cross-cut 710.	None found.	—	—	—

The Poruba zone	The Justin and Konrád bands	Mine Žofie, cross-cut 721.	Scaphopods, pelecypods.	Only casts, usually siliceous, very rarely pyritic. Bivalve shells were complete.	Two fossiliferous layers, separated by a barren one.	Layers with fauna at various levels, only of local extent, usually with torsos of faunas. Fossils completely silicified; in sporadic layers, however, mixtures of variously fossilized remains, among which there are even calcareous ones.
		Mine Žofie, 7th gallery, cross-cut to seams Konrád-Gustav-Filip.	In the upper band crinoids and ostracods. In the lower band terebelloid tubes.	Only some remains silicified. Rare limonitization. Shells preserved, bivalve ones complete.	Two bands developed. In the upper one a mixture of variously fossilized remains.	
		Mine Václav, 4th gallery, cross-cut to the air-pit.	Pelecypods, gastropods, ostracods. Ovoid pyritic casts.	Everything completely silicified. Shells preserved, bivalve shells complete; infillings siliceous.	—	
	The Jindřich band	Mine Václav, 4th gallery, N.E. cross-cut.	Very abundant gastropods, rarely pelecypods and foraminifers, very rarely ostracods.	Everything completely silicified. Bivalve shells complete. Infillings siliceous, very rarely pyritic.	The wealth of the fauna diminishes in vertical direction. Two fossiliferous layers.	Sorted, completely silicified, fauna of local extent and importance.
		Mine Žofie, 7th gallery.	None found.	—	—	
	The Koksová band	Mine Žofie, 7th gallery.	Very rarely gastropods, crinoids, fish.	Remains have preserved lime content.	—	Some fossils bleached-out. Shells usually have preserved lime content. Pyritization rare.

Zone	Faunal band	Locality	General composition of the small fauna	Mode of fossilization of the small fauna	Remarks	Outstanding features
The Poruba zone	The Koksová band	Mine Václav, 4th gallery, N.E. cross-cut.	Pelecypods, scaphopods, rarely gastropods, foraminifers, crinoids, very rarely fish.	Shells often preserved, calcareous, some of them bleached-out, bivalve ones complete. Infillings siliceous and argillaceous, rarely pyritic.	—	
		Mine Václav, 4th gallery, cross-cut to the air-pit.	Pelecypods, gastropods and scaphopods, rarely crinoids and foraminifers.	Shells calcareous, bivalve ones complete; infillings siliceous, argillaceous, rarely pyritic. In some layers bleached-out and limonitized shells together with normal ones.	—	
		Mine Václav, 6th gallery.	Pelecypods, rarely gastropods, foraminifers and ostracods.	Shells calcareous, bivalve ones complete; infillings siliceous or argillaceous.	Only one sample taken.	
	The Gabriela bands	Mine Žofie, 7th gallery.	Scaphopods, crinoids, spherical pyritic casts. Fossils only in some layers, always very rarely.	Remnants of shells bleached-out and normal, mostly silicified. Pyritic casts.	Some isolated layers with torsos of faunas. Rare pieces of wood (pyritized, partially carbonized, undeformed).	Because of scarcity of fauna and its deposition in isolated layers of various extents, lying at most varied levels, the bands are hard to correlate. Shells preserved, some of them bleached-out mostly completely silicified.
		Mine Václav, 4th gallery, N.E. cross-cut.	Pelecypods, very rarely fish remains. Spherical pyritic casts.	Shells calcareous only in some layers. Siliceous and pyritic infillings.	—	
		Mine Václav, 4th gallery, cross-cut to the air-pit.	None found.	—	—	

The Jaklovec zone	The Barbora bands	Mine Fučík I, above the 5th gallery.	Gastropods (planispiral and trochospiral forms) and ostracods, rarely pelecypods, scaphopods, stick-like excrements. Very rarely crinoids and foraminifers.	Numerous separated valves of ostracods besides complete ones in some layers. Shells excellently preserved, only very rarely silicified. Infillings siliceous, here and there even pyritic ones frequent. Limonitization very rare.	Gastropods dominate in numerous layers. Ostracods dominate in some others. Pyritization frequent in some layers.	Layers with a fresh-water or a mixed fauna in the basal beds in the area of mines Václav and Cingr II, higher up an alternation of layers with a fresh-water and a marine fauna. Sorted fauna frequently appears in marine-fauna bands so that crinoids predominate in some areas and layers, gastropods in others, ostracods in still others, and the like.
		Mine Fučík II, 5th gallery.	Ostracods, pelecypods, gastropods (planispiral and trochospiral forms), scaphopods, very rarely foraminifers, crinoids, brachiopods. Stick-like excrements. Spherical and oval pyritic casts.	Separated valves rare. Shells perfectly preserved, only very rarely silicified. Limonitization very rare. Infillings siliceous, only locally even pyritic ones frequent.	The fauna is dominated by ostracods. Pyritization more frequent only in some layers. Some layers formed of calcareous claystones.	
		Mine Trojice, 2nd gallery.	Ostracods, pelecypods, gastropods, very rarely foraminifers, crinoids and scaphopods.	Bivalve shells complete, rarely separated valves. Shells perfectly preserved, only very rarely silicified. Pyritization and limonitization rare. Prevalent majority of infillings siliceous.	Layers with fresh-water fauna have not been found in the basal beds. The fauna is dominated by ostracods. Pyritization rare.	
		Mine P. Cingr II, 2nd gallery.	Thecamoebinas and crinoids.	Crinoid columnal limonitized.	Developed in the lower layers above the Barbora seam. Mixture of fresh-water and marine fauna.	Of the foraminifers, *Apterrinella augustai* and some others appear for the first time.

Zone	Faunal band	Locality	General composition of the small fauna	Mode of fossilization of the small fauna	Remarks	Outstanding features
The Jaklovec zone	The Barbora bands	Mine Vávlav, 6th gallery.	Crinoids, ostracods, pelecypods, gastropods, foraminifers.	Shells more or less silicified, bivalve ones mostly complete; infillings siliceous or pyritic. In some layers striking mixtures with bleached-out and limonitized fossils.	Layers with varied fauna and fossilization. Crinoids accumulated in some layers, ostracods and pelecypods in others. Pyritization frequent.	Pyritic infillings of tubes are missing.
		Mine Vávlav, 4th gallery.	Fresh-water pelecypods and thecamoebinas in basal layers; intercalations with scaphopods. Higher up purely marine fauna: gastropods (planispiral and trochospiral forms), pelecypods, ostracods, crinoids, scaphopods, foraminifers, and very rarely fish teeth.	Everything silicified in basal layers, shells mostly preserved. At higher levels, the fossilization often varies and mixtures of variously fossilized remains appear. Shells mostly preserved, often silicified. Bleaching and limonitization frequent in some layers. Infillings siliceous and argillaceous; very rarely pyritic (only in some layers).	A series of layers with varied fauna and fossilization. Gastropods and/or crinoids accumulated only in some layers. Pyritization very rare.	
	The band below the 6th Jaklovec seam	Mine P. Cingr II, 2nd gallery.	None fauna.	—	—	

The Hrušov zone	The Flora and Enna bands	Mine Vávlav, 6th gallery.	Very abundant pyritic infillings of tubes (of worms?), very rarely ostracods and scaphopods.	Silicified remains, siliceous and pyritic casts.	Only one of the layers with pyritic infillings of tubes well developed.	Numerous crinoids, but only in some layers. Of the foraminifers, hyperamminas appear. Conspicuous layers with very abundant pyritic infillings of tubes. Individual layers have various regional extents. Some fossils bleached-out.
		Mine Šalomoun, 6th gallery.	Ostracods, gastropods, scaphopods, pelecypods, very rarely foraminifers and crinoids. Pyritic infillings of tubes.	Almost all shells leached out, the remaining ones silicified (except for a simgle case). Bivalve shells originally complete. Infillings pyritic, rarely siliceous.	Correlation possible with the layer at 3-9.5 m. above the Enna seam in mine Zárubek.	
		Mine Alexander, 5th gallery.	Crinoids, ostracods, rarely pelecypods and foraminifers; in upper layers gastropods, very rarely echinoids. In one of the layers also brachiopods and cephalopods. Very rarely fish remains. Pyrytic infillings of tubes.	Striking mixtures of variously fossilized remains: bleached-out, limonitized, pyritized, silicified. Shells often preserved, often silicified, bivalve ones complete. Infillings siliceous and pyritic, extremely rarely calcareous. Rare pyritic metosomatoses of shells.	The roof of seam Flora barren. Above seam Enna a greater number of fossiliferous layers, some of them with sorted fauna (crinoid layers). Mixtures of variously fossilized remains frequent.	
		Mine Zárubek, 10th galler.	Crinoids, ostracods, rarely pelecypods, very rarely echinoids, foraminifers and fish teeth. Pyritic infillings of tubes.	dtto	Above seam Flora two isolated layers with fossils (pelecypods and fish teeth). Above seam Enna several thicker fossiliferous layers, some of them with sorted fauna (crinoid layers) and with greatly varied fossilization of remains. Undeformed wood tissues, partially carbonized, partially pyritized.	

Zone	Faunal band	Locality	General composition of the small fauna	Mode of fossilization of the small fauna	Remarks	Outstanding features
The Hrušov zone	The Pipin band	Mine Jeremenko, 7th gallery.	Terebelloid tubes, a spherical pyritic cast. Undeterminable remains.	—	—	Developed only locally, similar to the Roland bands. Terebelloid tubes present.
		Mine Jeremenko, 1st div. below the 6th gallery.	None found.	—	—	
	The Roland bands	Mine Šalomoun, 9th gallery, upper part of the roof of the seam.	Ostracods.	Silicified complete specimens.	Upper part of the roof of the seam.	Not clearly developed, only of local extent and easily to be confused with locally developed bands at other levels and in other areas. Terebelloid tubes occasionally present.
		Mine Šalomoun, 8th gallery, roof of the seam.	None found.	—	Roof of the seam.	
		Mine Václav, 6th gallery, roof of the seam.	None found.	—	Roof of the seam.	
		Mine Alexander 8th gallery, roof of the seam.	None found.	—	Roof of the seam.	
		Mine Jeremenko, 7th gallery, main cross-cut, Ø 337 m., roof of the seam.	Fresh-water pelecypods, higher up casts of cavities of terebelloid tubes.	Pyritic casts and metasomatoses.	Band in the roof of the seam.	

The Hrušov zone	The Roland bands	Mine Jeremenko, 7th gallery, main cross-cut, basement of the seam.	Terebelloid tubes.	—	Band in the basement of the seam.	
		Mine Alexander 8th gallery, basement of the seam.	Ostracods in the lower band, in the upper one terebelloid tubes and undeterminable remains.	Ostracods silicified, complete.	Two bands in the lower basement of the seam.	
	The Františka band	Mine Václav, 6th gallery, experimental cross-cut.	Spherical pyritic cast.	Pyritic cast.	—	Considerable regional differences in the composition of fauna. Striking predominance of pelecypods in the area examined. Mixtures of freshwater and marine forms found only within a small area. Shells well preserved, partially silicified. Pyritization very rare.
		Mine Jindřich, 8th gallery.	None found.	—	—	
		Mine Bezruč, 5th gallery, main cross-cut.	Very abundant pelecypods, rare gastropods (planispiral and trochospiral forms), very rare scaphopods, ostracods and tentaculites.	Bivalve shells complete, partially silicified; infillings siliceous, exceptionally pyritic.	In some layers mixtures of marine, fresh-water and terrestrial (wood) organisms and indications of sorting according to size.	
		Mine Bezruč, 12th gallery, N. main cross-cut.	Pelecypods very abundant, gastropods, scaphopods and ostracods more rare.	Occasionally mixtures of variously fossilized remains. Shells often preserved, occasionally calcareous, bivalve ones complete. Infillings siliceous, more rarely pyritic.	Band of several parts with quantitatively different fossilization.	

Zone	Faunal band	Locality	General composition of the small fauna	Mode of fossilization of the small fauna	Remarks	Outstanding features
The Hrušov zone	The Františka band	Mine Šalomoun, 8th gallery.	Very frequently pelecypods, rarely ostracods, gastropods (planispiral and trochospiral forms), scaphopods; trilobites?	Occasionally mixtures of variously fossilized remains. Bivalve shells complete; infillings predominantly siliceous, rarely pyritic. Shells have preserved their lime content to a certain extent only in the upper part of the band; in the lower part they are completely silicified. Bleached ostracods are admixed in the uppermost layer.	Band of two parts with quantitatively different fossilization in these parts as well as at some of their levels.	
The Petřkovice zone	The upper Nanetta band	Mine Šverma, 6th gallery.	Ostracods, pelecypods, gastropods (planispiral and trochospiral forms), scaphopods.	Mixtures of variously fossilized remains. Shells silicified, often leached out, bivalve ones originally complete. Infillings pyritic, argillaceous and siliceous, the latter chiefly in ostracods.	Variously strongly pigmented siliceous casts together.	Proportion of pyritic casts strikingly smaller than that in the lower band.
		Mine Stalin II, 3rd gallery.	Ostracods, pelecypods, stick-like pyritic casts.	Mixtures of variously fossilized remains. Shells sometimes preserved, but silicified, bivalve ones originally complete. Infillings siliceous and pyritic.	Dtto	

The Petřkovice zone	The lower Nanetta band	Mine Šverma, 6th gallery.	Pelecypods, gastropods (planispiral forms), scaphopods, spherical pyritic casts (of radiolarias?).	Occasionally mixtures of casts of varied composition. Bivalve shells originally complete. Shells leached out. Casts predominantly pyritic, very rarely siliceous. Pyritized pieces of wood, undeformed.	Band composed of isolated fossiliferous layers of various extents, differing in fauna and fossilization.	Shells completely leached out, except for extremely rare cases. Pyritic casts entirely predominate. Infillings of ostracods, however, are predominantly siliceous, but ostracods are rare. They occur most frequently in upper layers.
		Mine Stalin II, 3rd gallery.	Ostracods, gastropods (planispiral forms) and scaphopods.	Occasionally mixtures of casts of varied composition. Almost all shells leached out; bivalve shells originally complete. Casts predominantly pyritic, rarely siliceous (in ostracods).		
		Mine Vít. Únor, 8th gallery.	Ostracods, pelecypods, gastropods (planispiral forms), scaphopods.	Shells leached out; bivalve ones originally complete. Casts predominantly pyritic, in ostracods siliceous.		
		Mine Stachanov, 7th gallery.	Ostracods, pelecypods, gastropods, scaphopods, spherical and cylindrical pyritic casts.	Occasionally mixtures of casts of varied composition. Shells leached out; bivalve ones originally complete. Almost all casts pyritic; siliceous ones predominate only in the uppermost layer.		

Zone	Faunal band	Locality	General composition of the small fauna	Mode of fossilization of the small fauna	Remarks	Outstanding features
The Petřkovice zone	The band below seam Otakar	Mine Stalin II, 3rd gallery.	Ostracods, scaphopods, pelecypods, pyritic infillings of tubes and spherical casts (of radiolarias?).	Almost all shells leached out, bivalve ones originally complete. Casts argillaceous, siliceous, very rarely pyritic. Mixtures of casts varied in composition. Undeformed pyritized pieces of wood.	Band with barren layers. There are all indications for its being a new one.	Pyritization extremely rare, except for pyritic infillings of tubes of organisms and pyritized pieces of wood. Fauna poor and uniform.
	The Bruno bands	Mine Vít. Únor, 8th gallery.	Ostracods, gastropods.	Argillaceous and siliceous casts. Ostracods originally complete.	Typical locality not accessible. Determination of the lower and the upper band meets with difficulties in other localities because of questionable identification of the seams. The finds probably coming from the upper band formed by isolated fossiliferous layers.	Infillings of shells preserved, bearing rarely remnants of silicified shells. Infillings argillaceous or siliceous; pyritization slighter than that in the Leonard band.
		Mine Stalin II, 3rd gallery, main cross-cut 71, Ø 1040 m.	Ostracods, gastropods (planispiral forms), spherical pyritic casts (of radiolarias?).	Shells leached out, except for very rare remnants inside some casts; bivalve shells originally complete. Casts siliceous and argillaceous.		
		Mine Stalin II, 3rd gallery, main cross-cut 71, Ø 1058 m.	None found.	—		
	The band below seam Viléma	Mine Urx, 6th gallery.	None found.	—	—	—

The Petřkovice zone	The Leonard band	Mine Urx, 5th and 6th galleries.	Gastropods (planispiral and trochospiral forms), scaphopods, very rarely ostracods, pelecypods. Spherical pyritic casts (of radiolarias?).	Shells leached out; bivalve ones originally complete. Mixtures of casts of varied composition (predominantly pyritic, very rarely siliceous). Pyritic metasomatoses.	Band of isolated fossiliferous layers with various faunas and various regional extents. Occasionally undeformed, pyritized, partially carbonized pieces of wood.	Calcareous shells perfectly removed; only imprints are left and rarely casts, mostly pyritic. Only locally developed.
		Mine Odra, 4th gallery.	None found.	—	—	
	The Theodor band	Mine Urx, 6th gallery.	Ostracods, pelecypods, gastropods, scaphopods, crinoids (assorted into a single layer). Spherical pyritic casts (of radiolarias?).	Mixtures of variously fossilized remains. Shells mostly leached out, rarely calcareous; bivalve shells originally complete. Casts siliceous (some of them strongly pigmented) and pyritic.	Band of isolated fossiliferous layers with various faunas (sometimes sorted), and with various extents. Occasionally undeformed, carbonized, partially pyritized pieces of wood.	Infillings of shells preserved, bearing rarely remnants of shells, which have preserved their lime contents to certain degrees in some layers.
		Mine Lidice, 4th gallery.	Ostracods, scaphopods, spherical pyritic casts (of radiolarias?).	Pyritic and argillaceous casts. Bivalve shells originally complete.	A small number of remnants of a fauna, which, however, does not afford a true picture of its composition and preservation.	—
	Štúr's band	Today inaccessible	—	—	—	—

Two bands appear higher up. They are separated from each other by a barren layer. The lower band (150 cm.-210 cm. above the seam) bears abundant gastropods together with pelecypods, ostracods and crinoids. Scaphopods appear very rarely. Echinoid remains appear at the base. The fossils are often completely silicified and only some of them have preserved their lime contents to certain degrees. The infillings are siliceous, pyritic ones occurring also at a higher level. The upper band (300-360 cm. above the seam) bears rarely calcareous shells of pelecypods; only at the base of this band are the pelecypods associated with gastropods and the shells are rather strongly silicified.

Sampling was also done in mine Žofie, cross-cut 720. The roof of the seam as high up as 140 cm. is without any fauna. Only a single band has developed higher up (145-180 cm. above the seam). Its fauna resembles in its composition and fossilization that from the upper portion of the above-described lower band. The band bears only fragments of valves of larger pelecypods and rarely gastropods. Everything is completely silicified except for some fragments of thick-walled valves.

No succession of fossils that might point to a gradual deepening and saltening of the water space is perceptible in the upper Roemer band, or in many others. *At the very base of fossiliferous claystones purely marine organisms, such as crinoids and echinoids, appear together with the other fauna. Regional differences in the development of the bands are striking.*

Gaebler's band

The thickness of the faunal band strongly varies and the height at which the band is deposited above the nameless twin-seam varies regionally as well. In mine Žofie in cross-cuts 710 and 720 the top of the twin-seam passes through coal shale directly into the marine-fauna band, and an extremely rich small fauna of foraminfers, crinoids, gastropods and of other purely marine forms appears already in the places of this transition (both in the claystones and in the coal laminae).

Gaebler's band is, as to the fauna, the richest of all the bands of the Poruba zone in the area examined. In mine Žofie (cross-cuts 503, 710, 720) it bears representatives of foraminifers, ostracods, of trilobites, pelecypods, gastropods, cephalopods, echinoids, crinoids, etc. *No indications of a succession corresponding to a deepening or shallowing have been found. Purely marine organisms appear already as low down as the places of the transition of the twin-seam into the overlying band and many crinoid columnals are, e. g., coated with coal matter. The holotype of the species* Liroceras gavendi Přibyl et Růžička *stuck with one side in coal matter. Lingulae appear not only with foraminifers but also with cephalopods, crinoids, ostracods, etc. Foraminifers and other organisms appear not only with dasycladaceas but also with cephalopods and other most varied forms. The uppermost part of the fossiliferous sediment bears as exacting marine organisms as the other parts* (so e. g. crinoids, ostracods and undeterminable fragments of fossils appear in the uppermost faunal layer in mine Žofie, cross-cut 720, at a height of 479 cm. above the twin-seam). The wealth of the fauna somewhat varies both vertically and regionally. *In some places at the base there are richer accumulations of fossils.*

The sorting of fossils is indicated by a sudden increase in their number above the base of the band and by a gradual vertical decrease in their number, in which no fundamental changes in the composition of the fauna occur.

The fossilization is very interesting. Bivalve shells are complete. All the shells are well preserved and have maintained their lime contents. The dark ochrous colour of the shells is conspicuous. It is darker than that of most fossils from other bands rich in fauna. Some fossils (e. g. some crinoids and gastropods) show a slighter bleaching or, on the contrary, limonitization. The infillings of the cavities of bivalve shells are calcareous. But pyritic infillings also occur rather frequently. A small number of pyritic infillings of tubes (of worms?) appear sporadically.

One of the outstanding features of Gaebler's band is the lime content. The matrix is calcareous, which is a rare phenomenon in the Ostrava beds.

TAXIONOMIC EVALUATION OF THE MICROFAUNA

The foraminifera have been described (M. V a š í č e k and B. R ů ž i č k a, 1957). Some species of foraminifera are very rare. They have been found only in lumachellas of microfossils, which appear extremely rarely. Therefore, we may expect that new foraminifera will be discovered in the nearest future.

Representatives of thecamoebina have been encountered in some bands with a fresh-water and a mixed (fresh-water and marine) fauna. Their description is being printed (M. V a š í č e k and B. R ů ž i č k a, 1957). Practical importance of the presence of thecamoebina in fresh-water fauna bands lies in the fact that such bands may be identified by micropaleontological methods.

The microfauna is represented in the richest way by ostracods. The ostracods are, for this reason, the most suitable biostratigraphical material.

Their description has been prepared by A. P ř i b y l. The preliminary report by this expert (A. P ř i b y l, 1956) proves the key importance of the ostracods in the microbiostratigraphy of the Ostrava-Karviná coal district. The synthetic work is being prepared for print.

It was not possible to fully prove the presence of the radiolaria. Smooth and warted pellets of fine-grained pyrite appear sporadically chiefly in the lower Ostrava beds. They could represent infillings of globular radiolaria. But not a single remnant of the test to prove conclusively the presence of radiolaria in the Ostrava beds has been found. Experiences with the microfauna from later sediments show that of all microorganisms it is diatoms and radiolarias that are most inclined to pyritizaion.

In the Ostrava-Karviná coal district globular pyritic casts have as yet been found only in the marine-fauna bands or in their equivalents without any fauna. Therefore, they may be made use of for the identification of marine-fauna bands also in the areas where the beds are without other fauna.

Conodonts have been met with in numerous Carboniferous coal-bearing sediments. But they have not been encountered so far in the Ostrava-Karviná coal district. That is probably because there are no limestones in the sediments, with which the presence of conodonts is most often associated.

The columnals of crinoids are usually classed among the microfauna. They are abundant in some faunal bands of the Ostrava-Karviná Carboniferous. They have not been the subject of a systematic investigation for the present.

Fish teeth and other fish remains were found extremely rarely. For this reason, they are not useful for practical microbiostratigraphy and did not receive special attention.

Of course, small pelecypods, gastropods, cephalopods, trilobites, etc., often occur among the microfauna. They mostly represent immature individuals, unsuitable or less suitable for taxionomic evaluation.

This review has shown that no constituent of the microfauna reaches in the Ostrava-Karviná coal district the stratigraphical importance of ostra-

cods. The thecamoebina and foraminifera are only of subordinate significance. The same applies to the other microfauna.

As some features point to the allochthoneity of numerous fossils, faunal lists are not always a reliable and adequate basis for the identification of individual fossiliferous bands.

THE FREQUENCY OF FAUNAL BANDS

The frequency of marine-fauna bands differs completely in the Ostrava beds from that of the fresh-water-fauna bands. This fact is of some importance for the elucidation of the origin of cyclothems of the Ostrava type.

Marine-fauna bands and fresh-water-fauna bands appear only very rarely in one and the same upper division of a cyclothem. The upper divisions of cyclothems most often have either intercalations with marine fauna or those with fresh-water fauna.

Regionally developed marine-fauna bands usually appear at the uppermost levels of the individual zones. At the other levels they appear only rarely (the Františka bands) and are substituted by locally developed marine-fauna bands and fresh-water fauna bands, which do not alternate regularly. The bands lying in the middle parts of the zones are mostly unsuitable for correlation, because these middle parts often bear a greater number of only locally developed layers with torsos of fresh-water, of marine and often also of mixed fauna. This applies especially to the Hrušov, Jakovlec and Poruba zones.

There exist certain relations between the character of the faunal bands and that of the cyclothems. Well developed marine-fauna bands of regional extents commonly appear in the so-called seamless sediments, that is in the successions of cyclothems with poorly developed seams and very thick upper divisions. The fresh-water fauna bands commonly appear in the successions of somewhat smaller cyclothems with the seams of respective development. As the successions of cyclothems similar to one another rather frequently appear, the vertical successions of faunal bands similar in character are not rare.

If fresh-water-fauna layers and marine-fauna layers appear together in one and the same upper division of a cyclothem, the former usually underlie the latter or alternate with them.

MODES OF FOSSILIZATION AND THEIR USE IN CORRELATION

Calcareous organic remains are more or less leached in some bands while in others they are preserved. Some bands bear organic remains that are more or less silicified and decalcified. Bivalve shells of small and immature individuals are complete in the absolute majority of the faunal bands. The inner cavity is most often filled up with a material different from that in which the shells are deposited (with pyrite or quartz, very

rarely with calcite). Some faunal bands bear only casts, others only imprints of shells, whereas the others bear tests preserved. Remains different in fossilization were found together almost in all the faunal bands: highly pigmented beside slightly pigmented; bleached out through weathering beside normal ones; pyritized beside limonitized ones; and the like. The occurrence of undeformed plant tissues both carbonized and pyritized is also interesting.

Obviously, the differences mentioned can be made use of in stratigraphy.

A certain succession of dominant fossilization appears in every naturally limited zone. The silicification is usually slighter in the faunal bands lying in the basal beds than in those lying in the middle, while it is slightest in the uppermost ones. The upper development is missing in the Petřkovice zone in the places where the flora changes suddenly.

Shell material was completely removed only in the middle part of the Petřkovice zone. Perfect imprints and casts are all that has remained of fossils in the Leonard band. Casts have remained in the Otakar (= Nanetta) and Theodor bands and still bear remnants of shells in some layers and in some places. In the marine-fauna bands deposited in the other Ostrava beds, the shells are usually preserved; they have been removed only in some layers of these bands. Casts or metasomatoses have, however, been found in every case.

LIME CONTENT OF FOSSILIFEROUS SEDIMENTS

In the Ostrava part of the Upper-Silesian feredeep it is only some layers of black-gray claystones in the Barbora bands and the claystones of Gaebler's band that are calcareous. All the other fossiliferous bands in the Ostrava beds are formed by uncalcareous sediments and only some fossils still retain their lime contents in some layers. In the identification of individual bands, one must ascertain separately both the lime content of the matrix and of the fossils enclosed.

DISTRIBUTION OF COARSER SEDIMENTARY PARTICLES

The distribution of coarser particles was traced in both the fossiliferous and barren claystones and sandy claystones in the upper parts of cyclothems of the Ostrava-Karviná coal district. Many layers bear quartz grains as an alien admixture. Wind-worn, well rounded grains with frosted surfaces, without traces of polishing in a water environment are relatively rare. Quartz grains with limonitic coatings or stained with limonite occur as sporadically as the quartz grains that are chemically corroded in the weathering. Quartz grains polished to various degrees in a water environment appear more frequently, while the perfectly polished ones are rare. Wind-worn and water-worn grains rather frequently occur together with limonitized and corroded ones.

No rule and conspicuous deviations have been observed in the frequency of coarser quartz grains in the claystones. Therefore, the distribution of coarser particles seems to be of no use in stratigraphy.

The described phenomenon, however, is interesting from the paleographical point of view. If the origin of wind-worn material is contemporaneous with the origin of coal-bearing sediments, wind-deposited sands must have existed at the time of the formation of coal seams. If the same applies to the origin of chemically corroded grains, the areas with a very intensive subaerial weathering must have existed at the time of the origin of coal-bearing deposits. Unfortunately, the time of the origin of wind-worn and chemically corroded grains cannot be proved. Especially wind-worn material may be disproportionately earlier than the sediments into which it has been broupht in.

EXPERIMENTS AND OBSERVATIONS ELUCIDATING THE CONDITIONS OF THE ORIGIN OF FAUNAL AND FLORAL BANDS

Complete shells of pelecypods, brachiopods and ostracods appear almost without any exception in the wash-residues of samples coming from all the faunal bands examined. A greater number of separated valves have been found only in samples coming from some layers overlying the Barbora seam in mine Fučík I. Of course, it is only small specimens that remain preserved in wash-residues so that, more exactly speaking, bivalve shells of small and immature individuals have remained complete. As said before, the shells are, with the exception of very rare instances, firmly closed and the cavities are filled up with a material different from that in which the shells are deposited (with quartz or pyrite, very rarely with calcite). In order to elucidate the causes of this phenomenon, a number of experiments and observations have been made.

Laboratory experiments with fresh-water ostracods have brought much information. After having been skinned, the carapaces of immature individuals remain connected with the exuvium in the places of muscle scars, disconnect, however, in the hinge margin and remain wide open. Living individuals respond to mechanical, chemical and electric stimulations by firmly closing the carapaces. After the natural death of individuals or after their killing through electricity, the carapaces opened immediately or after a few hours. In the case of sedimentation, the inner spaces of such individuals would be filled up with sediment. If dead individuals are kept with living ones, they are attacked by them and in a few days the valves are completely separated from each other. The carapaces remain closed even after the death of the individual only in rare instances. As far as it could be observed, it occured when the individual got stuck among algae or in mould. Such instances, however, only amounted to about ten percent of the total number of dead individuals. When the individual was taken out of the water, it dried up with firmly closed carapaces. When it was afterward put on the water, it floated till the carapaces opened so broadly as to enable the enclosed air bubble to escape. When the water was strongly or slightly saltened, the individuals perished sooner or later, the carapaces opened, the abdomen protruded, became strongly swollen and finally burst. Hence it follows that individuals carried by fresh water into salt water cannot be preserved complete with closed carapaces in the case of particle-by-particle sedimentation. Experiments were also made with individuals suddenly buried under mud. All of them were able to find their way to the surface.

The results of the experiments suggest clearly what particular conditions are needed to enable the forms with a simple (probably also with a specialised) hingement to fossilize in bulk with closed carapaces without being filled up with sediment as it is the case in the faunal bands of the Ostrava-Karviná Carboniferous. The individuals must be killed suddenly or at least paralysed in the state of excitation (with closed carapaces) and contemporaneously buried under such a thick cover of sediment the weight of which would make it impossible for the carapaces of dead or paralysed individuals to open. Such conditions may probably be brought about by revolutionary sedimentary processes, especially by turbidity currents. It is

a swift change in the hydrostatic pressure as a result of the transport into depths that may cause the paralysis or killing in the state of excitation without the destruction of firmly closed carapaces, since in the case of changes in the pressure the changes in the volume of water are slight. A swift deposition of specimens together with detritus follows a slackening of the velocity of the current. The detritus deposited does not allow the carapaces to open. The organism having been decayed, the inner cavities are, some time after, filled up with material deposited from solutions (with calcite, quartz, and the like), or with pyrite.

The present writer (1956) had a chance to examine the deposition of shells of organisms in the beach and shallow-water sediments at the southern coast of the island of Hainan. It was especially pelecypods of the most varied species and sizes that were open to study.

Individual valves of pelecypod shells lie separately on the beach and in backshore and foreshore sediments. It was only specimens of the Cardium that were found (of course, only exceptionally) with the closed crenate margins of their valves. *The closed inner space was always filled up with sand, hence with the same material in which the closed shells were deposited.*

Almost all valves of pelecypod shells lie at the shallow bottom separately. Open shells of very recently perished pelecypods appear only rarely. Closed shells of pelecypods that perished long ago appear extremely rarely. If we open them, we can see that they are at least partially filled with the same (!) material in which they lie. We can easily understand this phenomenon. If a dead pelecypod remains lying on the flank and if crabs and other animals do not destroy the shells, the ligament decays some time after and the shells close again more or less owing to the weight of the "upper" valve. If the margins of valves are crenate, as e. g. in the case of the Cardium, slighter movements of water cannot open the shells of such individuals. However, such *closed shells always contained a sediment from the time when the shells were open. Of course, it is always the same sediment in which the shells lie.*

It was possible to observe the same phenomenon, of sourse already fossilized, in the beach rocks, which are nothing but consolidated littoral sediments. The valves were predominantly separated. When the shells of pelecypods remained semi-closed or closed, they were always filled at least partially with the same sediment as was to be found in the surroundings: with sand. Closed empty shells were not encountered. As far as it could be observed, valves with smooth, even, non-crenate margins were always deposited separately. Closed shells were found only in six instances and that is an extremely slight percentage in comparison with thousands of other cases. They belonged to the Cardium.

As to pelecypods and ostracods burrowing in sediments and remaining there after death, very few observations have been acquired that do not allow conclusions of more general validity.

The afore-mentioned experiments and observations show what an enormous difference exists between the mode of preservation of bivalve shells in backshore, foreshore and shoreface sediments and in the sediments of the Ostrava-Karviná Carboniferous. Every faunal band directly overlying

a seam should begin with an ingressive layer in which organic remains should be deposited and fossilized in the same way as it is in very shallow waters. Every faunal band should terminate in a regressive layer in which organic remains should be fossilized in a similar way. No layers have been found that could be considered ingressive or regressive, with the exception of isolated and locally developed layers in the Barbora faunal bands in mine Fučík I (which represent neither bases nor roofs of the bands).

The allochthoneity of fossils in the Ostrava beds is also attested to by other phenomena. The occurrence of remains of purely marine organisms in coal matter is one of the most conspicuous. So e. g. in the 720th cross-cut in mine Žofie a nameless twin-seam passes through coal shale into the rich Gaebler faunal band. Numerous columnals of the crinoids, of organisms that cannot stand brackish and fresh water, are enclosed in coal laminae of the shale and coated with coal matter. The shell of the cephalopod *Liroceras gavendi* Přibyl et Růžička sticking with one side in the coal seam was found by Gavenda at the same level.

The varied mode of fossilization of organic remains deposited together is another important document of the allochthoneity of many fossils. This phenomenon is to be observed in many faunal bands, in some of them especially conspicuously. Especially the distribution of bleached-out fossils subject to a certain rule is worth mentioning. Fossils that are attacked through weathering and bleached out appear in a more striking number in the Enna and Barbara faunal bands and to a smaller extent also in the faunal bands overlying the Zámek conglomerates. This distribution is especially conspicuous for the fact that the faunal bands mentioned lie at levels showing certain connections to paleogeographical changes. The symptom of these changes is to be seen in the large group of faunal bands with freshwater fauna between the Enna and Barbora bands as well as in the Zámek conglomerates with a layer of subaerial soil in the basement. These conglomerates lie above the Barbora bands.

The sorting of some species of fossils into certain layers is a further document of allochthoneity. So e. g. one of the layers in the Theodor band bears only crinoid remains. It is not feasible that such exacting marine organisms as the crinoids should live in an environment in which other fauna would not prosper.

Further important facts have been afforded by the investigation of horizontal and vertical extents of faunal bands.

Larger faunal bands generally consist of isolated layers different in the regional extent that are separated from one another by barren layers. Therefore, the farther apart the cross-sections through one and the same band are, the more they differ. It is possible to correlate only some layers to a greater distance. The fauna of some layers differs strikingly from that of the adjacent layers and its composition sometimes points very clearly to a sorting. Regional changes of the fauna also correspond with that. The Barbora faunal bands are most remarkable in this respect; remains of the crinoids, gastropods, ostracods, etc. have often been assorted there into isolated layers. The faunal content changes laterally as well. Traces of such a sorting are to be observed even in many other bands.

The faunal bands of smaller extent usually consist of a single or some fossiliferous layers. As their character (faunal content and distribution) is analogous to that of the layers from larger bands, their importance for correlation is most frequently only local.

This information is especially valuable because recently numerous attempts have been made to correlate by the comparison of vertical changes in the composition of fauna, more exactly speaking, by the comparison of deviations from ideal vertical changes in the fauna. Ideal faunal successions have been constructed artificially under the influence of the belief that it was changes in the depth due to oscillations of bottom or water level of a sedimentation space that were responsible for the successions of individual kinds of sediments constituting cyclothems and hence for the faunal successions. A succession of kinds of sediments should correspond to a succession of presupposed evolutionary stages of the sedimentation space: to a regular alternation of the emergence (filling up) with deepening. All existing constructions of ideal cyclothems, however, have two weak points: Not a single cyclothem has been found so far to correspond exactly to the ideal established. The other weak point is the fact that the ideal cyclothem constructed on the basis of the confrontation of the reality with the idea (sandstone—shale—stigmarian soil—seam—fresh-water shale—marine shale) is neither realistic nor quite an ideal cyclothem. Marine shales should pass upwards, in an ideal cyclothem, into fresh-water shales and these into the sandstone that the succession of rocks should correspond to the idea of regular alternation of the emergence (filling up) with the deepening. The above-mentioned succession of rocks is not realistic because many cyclothems are without fossiliferous bands and the others most often bear either a fresh-water-fauna band or a marine-fauna band.

Ideal schemas of faunal successions have also been constructed in a similar way and on the basis of similar ideas of the origin and development of coal-bearing sediments. One of these schemas tries to replace the last two kinds of sediments lacking in the ideal cyclothem (upper fresh-water shale and sandstone) by condensing the whole transition to a presupposed continental phase into faunal bands. That is, of course, in discrepancy with another explanation of the strange termination of ideal cyclothems (removal of fresh-water shales and sandstones before the formation of a later cyclothem).

The investigation carried out in the Ostrava-Karviná coal district shows that no successions of faunas to correspond with the presupposed shallowing (freshening) and deepening (saltening) have been found. However, *layers have been found that contain sorted crinoids, crinoids with gastropods, ostracods, ostracods with pelecypods, pelecypods, etc. In the layers with sorted fauna, the fossils are grouped according to shape, not according to relationship or ecologic qualities. On the other hand, layers, or their parts, bearing an unsorted fauna most varied in composition are frequently found. Mixtures of fossils diverse in fossilization are frequent. It often happens that purely marine organisms (crinoids, etc.) frequently appear in the bases of fossiliferous bands.* Marine organisms sometimes appear close above the seams (roof of seam Enna), at other times even in the coal matter on the top of the seam (Gaebler's band). Mixtures of marine and fresh-

water faunas together with vegetal remains or those of a marine fauna and vegetal remains are occasionally encountered. A certain succession of fresh-water and marine fossils may be observed only in some bands (only in some of their vertical profiles), e. g. in bands Františka and Barbora. A detailed examination has shown that these successions are in reality a series of isolated layers with fresh-water, marine or with mixed fauna. So e. g. the Barbora faunal band in mine Václav bears at its base several layers containing a fresh-water fauna, a series of lyers with a marine fauna appear higher up and the band terminates in the layers bearing remains of purely marine organisms. There is no further transition into layers with a fresh-water fauna. Hence, the reality is different from the ideas based on the belief in the autochthoneity of coal seams and in the origin of cyclothems in connection with the alternate emergence (filling up) and deepening of the space of sedimentation. *The causes of the changes in the faunal content are not ecological; they are physical.* Because of this fact it is necessary, in the correlation, to take into account a purely local extent of some fossiliferous layers as well as lateral changes in the faunas due to sorting.

The sorting of fossils has also brought about other interesting phenomena that must be considered in the correlation as well. Some samples taken from layers bearing large fossils are without any small fossils whatever; some samples coming from layers that are barren macroscopically contain abundant small fossils. This implies that the so-called barren layers which have been ascertained in the micropaleontological examination do not always correspond to barren layers identified by the distribution of macrofossils. Therefore, it is only the layers in which no fauna has been found either by micropaleontological or macropaleontological methods that may be considered actually barren.

The afore-mentioned information and experiences supplement the information on the distribution of floristic and faunal (both marine-fauna and fresh-water-fauna) bands in cyclothems, which is subject to certain rules (fig. 1).

Fig. 1. Schematic demonstration of the gradation of material (A and B) and of the mode of bedding (C) in simply and completely developed cyclothems of the Ostrava type.
Profile A showing gradation of inorganic material: **a**—gravel; **b**—sand; **c**—clayey sand; **d**—sandy clay; **e**—fine-sandy clay; **f**—coal; **g**—roof clay; **h**—clay of evolutionary phase with intercalations formed by lateral facies of cyclothems and by redeposited clays. a-g—lower division of a cyclothem, h—upper division of a cyclothem.
Profile B showing gradation of phytogenous material: **1**—trunks, stumps and roots filled up with sand, and barks; **2**—rare plant remains (most frequently calamites and root remnants) deposited according to weight and sort of infilling either in the rock proper or on lamination planes; **3**—concentrated remnants of roots (separate, non-filled-up appendices are concentrated on indistinct lamination planes); **4**—concentrated coal-producing plant remains; **5**—concentrated coal-producing remains with numerous spores; **6**—spores and leaves; **7**—barren claystone containing intercalations with fauna, etc. 1-6—lower division of a cyclothem, 7—upper division of a cyclothem.
Profile C showing mode of bedding: **I**—compact, non-bedded sediment; **II**—parallel lamination, sometimes with convolute deformations and other synsedimentary phenomena; **III**—waved lamination; **IV**—current lamination, sometimes cross-bedding; **V**—indistinct parallel lamination; **VI**—compact claystones with various types of intercalations. I-V —lower division of a cyclothem, VI—upper division of a cyclothem.

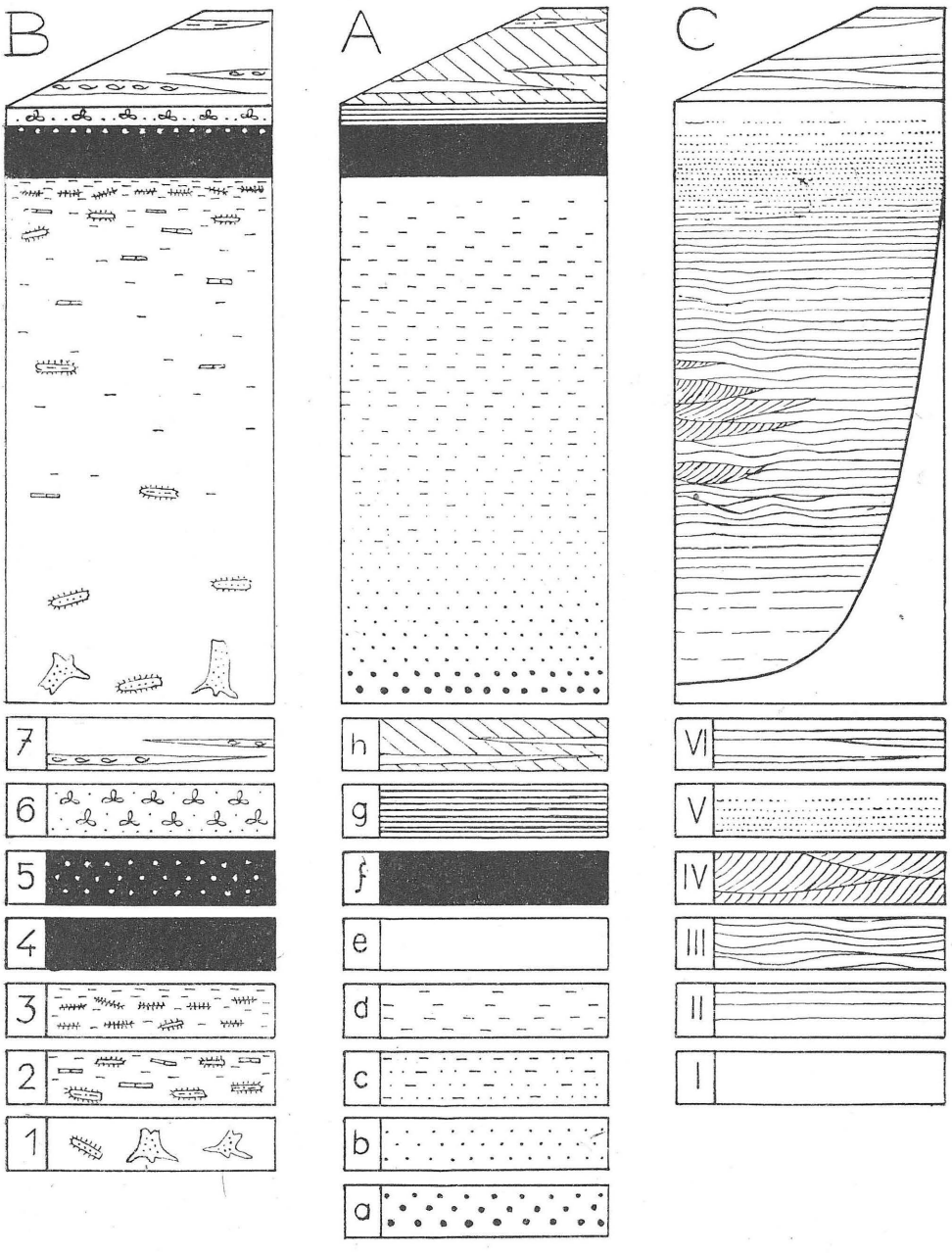

Fig. 1.

Every complete cyclothem of the Ostrava type consists of two divisions.

In the lower division there is a simple or intricate gradation from gravels and sands (deposited above the erosive base) over sandy shale, sandy claystone and the coal seam up to the more or less developed claystone roof of the seam. This gradation is also accompanied by a gradation of vegetal material. The sandstones bear only trunks and roots filled up with sand as well as some barks. The sandy shale contains roots and calamites (those that are not filled up with sand lie only on lamination planes, while those filled up with sand lie in the rock proper). The sandy claystone (underclay) below the coal seam usually bears only stigmarias. The other vegetal remains without mineral infillings appear in the seam, while fine, well preserved leaves appear in the claystone roof of the seam.

In the case of intricate gradation, the same law-adhering succession of sedimentary microtypes as that which occurs in many sandstone intercalations in the Flysh sediments appears in the lower divisions of cyclothems. In such a case, the homogeneous sandstone passes sooner or later into sandy shales with a simple parallel lamination. Waved and current laminations sometimes occur higher up. These sorts of lamination pass in the underclay and in the seam into an indistinct simple parallel lamination. This lamination is visible, in the underclay, from the arrangement of root remnants (separated appendices are often deposited in bulk on lamination planes) or after the weathering of the underclay. It occurs only in some instances that the underclay has no special texture. In coal seams indistinct lamination becomes visible owing to the alternation of heterogeneous material. The roof of the seam is usually textureless. Lamination is sometimes accompanied by syngenetical deformations (by convolute deformations, etc.). The afore-mentioned succession of sedimentary microtypes sometimes shifts upwards or downwards. So e. g. current bedding does not occur before the sedimentation of the seam (very rare case). In another case it occurs already in the basal sandstone (frequent case).

Erosion of the basement of cyclothems, gradation of inorganic and organic material, the described succession of sedimentary microtypes as well as syngenetic deformations in the lower divisions of cyclothems are phenomena that are typical of deposits from turbidity currents.

The characteristic of the lower divisions of cyclothems would not be complete if we failed to pay attention to phenomena that may be introduced as documents for another mode of the origin of the lower divisions of cyclothems. The presence of erect stumps, of plant remains penetrated by appendices of stigmarias, as well as an accumulation of stigmarias in underclays are usually introduced as documents of the autochthoneity of seams and thus indirectly also as documents of the particle-by-particle sedimentation.

Let us first consider erect stumps and trunks. They are always filled up with sand; only circumferential parts are usually carbonized. They appear in basal sediments of the lower divisions of cyclothems (in gravels, sands), but they usually do not appear in seams and finer sediments. No roots and trunks penetrate transversally the seams even when the matter

of seams bears a considerable amount of carbonized wood tissues. Let us compare these observations with actupaleontological observations. During his stay at Varna (Bulgaria) the writer observed how a stump had been thrown by surf onto the beach and deposited with the roots downward as if it had grown in the place where it was found. During a subsequent storm it floated away and was thrown again onto the beach at another place. It came to rest again in the erect position, with roots downwards. In the delta of the Fraser River J o h n s t o n (1921) found whole groups of such deposited stumps which had been brought in by the river. In the Straits of Malacca the writer observed remnants of trunks floating in erect position. If a stump has been soaked with water, it sinks to the bottom turned downwards with the parts of greater specific gravity (with roots). Water-soaked stumps that have been transported by turbidity and other currents must sink in the same way. The problem of the autochthoneity of erect stumps and trunks cannot, for those reasons, be considered as solved by a single fact observed—by ascertaining the erect position—because even redeposited trunks may come to rest in bulk in such a position.

Let us now consider parts of roots accumulated in underclays. The observations on their deposition are described in the subsequent part of this paper. Here, however, it is necessary to recall that of other plant remains it is most often only calamites, vegetal remains of greater specific gravity due to silica in cellular membranes, which accompany stigmarias more frequently. It was already F a y o l (1887) who proved by experiments that parts of roots are usually of greater specific gravity and so must come to rest earlier than many other plant remains. As to associations of vegetal remains of greater specific gravity in the lower divisions of cyclothems, it is necessary to comment further: stigmarias sporadically appear *at all levels* of the lower divisions of cyclothems. Sandy facies, however, bear only root axes and appendices filled up with sand; root axes with appendices in the more argillaceous facies are filled up only with clay or are without infillings. Separated appendices without infillings lie almost exclusively on lamination planes. The sandy infillings of root portions sometimes clearly differ from the surrounding sandstone; the argillaceous ones, from the surrounding claystone. All these facts draw our attention to the dependence of the occurrence, modes of preservation and deposition of root portions on the specific gravity of the matter of roots and their infillings.

Vegetal remains penetrated by appendices occasionally appear. As far as it is known to the writer, root axes from which appendices would jut out have not been found. There are no reliable documents to prove that vegetal remains were penetrated at the places where they were definitively laid down. It has been mentioned that coal seams have usually not been penetrated by roots even when they contain many wood remnants.

In accord with the vertical sorting of plant remains in the lower divisions of cyclothems, fine and the lightest remains (leaves) are only accumulated in a more considerable number as high up as the claystone roofs of the seams. This circumstance has, of course, been known for a long time. It has, however, caused that phytopaleontologists did not pay attention to the zonal distribution of other plant remains, which are practically worthless to them, in lower portions of the lower divisions of cyclothems.

As to the lower divisions of cyclothems one may conclude that *they do not bear faunal bands. They, however, contain floristic zones.* Plant remains accumulate according to the specific gravity of their own substance and of their infillings in certain zones in accord with the positive gradation of deposited material. Of course, the lower divisions of cyclothems cannot completely develop in the whole sedimentation area because the vertical sorting is accompanied by the regional.

On the other hand, the upper divisions of completely developed cyclothems do not show gradation of material and are usually formed by barren claystones. One may infer from these circumstances that they are a product of particle-by-particle sedimentation in an environment with unsuitable life conditions. They are variously thick and were deposited over variously long periods of repose.

Intercalations of material that is fresh-water, marine or mixed in origin usually appear in many upper divisions of cyclothems. Some of these intercalations are lateral and poorly developed facies of the lower divisions of cyclothems formed in adjacent areas. They are formed of analogous materials, have analogous textures as well as plant remains. Others, however, are formed of claystones and sandy claystones, or rarely of sandstones; for the most part the yare textureless; sometimes they are laminated. They rather frequently bear faunal remains. The thicker the upper division of a cyclothem, the more likely it is to contain intercalations with a fauna. In other words, the number on intercalations with a fauna is roughly proportional to the length of time required by the deposition of the upper division of the cyclothem. Of course, it has been known for a long time that the thickest and manyfold faunal bands appear in the so-called seamless beeds.

One may summarize: *bands with fresh-water, with marine or with mixed fauna are restricted to the upper divisions of cyclothems,* to claystone, very rarely to sandstone, intercalations that arose and repeatedly interrupted the sedimentation of barren claystones. The thicker the upper division, the more likely it is to bear intercalations with a fauna. On the other hand, deposits rich in flora are restricted to the lower divisions of cyclothems, the lateral parts of which may, of course, jut out as intercalations into the upper divisions of cyclothems contemporaneously formed in adjacent areas. We must add that plant remains appear here and there even in the intercalations with a fauna; their fossilization, however, differs in many instances from that of plant remains in the lower divisions of cyclothems. They are often without traces of deformations. Some of them are completely carbonized, others are partially carbonized and partially pyritized. Many of them are completely pyritized. Silicified plant remains also occur.

The described rules governing the distribution of floristic and faunal zones and bands, as well as their knowledge, are of great help in prospection.

The bands with fresh-water fossils and those with marine fossils very rarely appear together in one and the same upper division of a cyclothem. Almost invariably, one and the same upper division of a cyclothem bears only layers with marine fauna or layers with fresh-water fauna.

As to the faunal bands, one may conclude: All the observations and experiments carried out up to the present show that such a general preservation of complete bivalve shells as that which has been found in all the faunal bands examined cannot occur in sediments deposited particle-by-particle, especially in backshore, foreshore and shoreface sediments. Ingressive and regressive zones should occur in the bases and roofs of fossiliferous bands. They should bear separated valves of bivalve shells just as it is in shallow waters. Such ingressive and regressive zones have not been found in the Ostrava part of the Upper-Silesian foredeep. In addition to the joint occurrence of variously fossilized remains it is also these facts that show that the faunas are not in the places where they lived. They must have been redeposited. They could have been transplaced solely from shallower waters into deeped waters. The fossiliferous intercalations in barren pelites of the upper divisions of cyclothems show that the faunas were redeposited into an environment unsuitable for the growth of organisms. It is, of course, necessary to infer practical conclusions from this information. We must take into account that the redeposition of sediments with a fauna was of regional extent only at some times; at other times it was quite local. This elucidates the facts, which have been known for a long time, that it is only some of the faunal bands that are of wide extents; others have been found only at one or some few closely-spaced localities surrounded from all sides by barren sediments. Many faunal bands are not simple. They are usually formed by separate fossiliferous layers of various and different regional extents. Therefore, the number of layers varies at various localities and only some of them can be correlated. The faunal content of individual layers frequently varies and changes regionally even in one and the same layer. Practically this means that in an area that has not been examined quite new layers with a different fauna may be discovered, while other layers known from other localities need not be encountered.

THE STUDY OF THE CHARACTER OF STIGMARIAN ROCKS

The general occurrence of stigmarias in the underclays in the lower divisions of cyclothems is a rule which has exceptions. So e. g. in mine Václav in the 4th gallery the stigmarian rock is separated from seam Gabriela by a 12-15 cm. thick compact sandstone without traces of roots. But other interesting phenomena also occur. So e. g. below the Gustav seam at the same locality, the boundary between the underclay with abundant stigmarias and the underlying sandstones with vegetal detritus is sharp. In the Justin seam at the same locality, there is a claystone parting without traces of stigmarias, but with fragments of leaves on lamination planes.

Sandy claystone with numerous root remnants lies below the Nanetta seam in the Koblov Pass. This claystone is intercalated by two 2-3 cm. thick layers of sandstone without root remnants (!). The sandstones are finely laminated and the laminae are deformed through subsolifluction. Sandstone showing current lamination has been found on the slag heap of mine Václav. Casts of flow-markings are penetrated by appendices that are filled up with sand. The sandstone does not contain any root remnants whatever. Only the ends of separated appendices penetrate from the basement into the sandstone. On the same heap the writer found a layer of sandy claystone which lay on a layer of sandstone. The claystone was stuffed with root remnants, the sandstone, however, was quite barren.

Some stigmarian rocks bear only separated appendices lying exclusively on lamination planes. Other stigmarian rocks contain only appendices lying both on lamination planes and transversally (in these cases the appendices lying on lamination planes are usually

compressed, without infillings; the appendices penetrating transversally through the rock are usually filled up with sand or claystone). There are also stigmarian rocks which bear separated appendices as well as main roots with appendices (appendices attached to main roots most frequently diverge in all directions even when they are without infillings and even when separated appendices without infillings lie only on distinct or indistinct lamination planes). Horizontal deposition of main roots predominates in stigmarian rocks in some groups of cyclothems, while in others, main roots lie predominantly in various directions.

In addition to root remnants even other vegetal remains, usually stalks, sometimes appear in stigmarian rocks. *They are usually fossilized in the same way as the root remnants.* They are also as well preserved as the roots. They are most frequently calamites, vegetal remains of greater specific gravity due to silica in cellular membranes. Leaves have been found only in the finest stigmarian rocks which, of the roots, contained the appendices only. They are extremely rare.

Stigmarias are sometimes filled up with the same rock in which they lie, at other times with a different rock, while in still other cases with various rocks. So e. g. in the black-gray underclay of a nameless thin seam between seams Lothar and Konrád in the 4th gallery of mine Václav a root with appendices lying in horizontal position has been found. It was filled up with lighter argillaceous matter, grown yellowish in colour through weathering (chemical, thermic and X-ray analyses have attested this difference; see fig. 4). Loose appendices in the proximity of this root are either without any infilling or are filled up with gray-white sandstone. A main root filled up with the same material as that which enclosed it was found in a sandy stigmarian rock, while another one, in the vicinity, was filled up with a different material, with pinkish sandstone.

The foregoing part of this chapter dealt, among other things, with the vertical arrangement of plant remains in the lower divisions of cyclothems. Parts of roots have usually been accumulated most abundantly in the basements of coal seams. According to the specific gravity of their infillings and/or of their own matter they have been deposited in sandy or sandy-clay to clayey rocks showing distinct or indistinct lamination. As the content and deposition of root remnants are different in various stigmarian rocks, an attempt has been made to typify them. A tentative profile has been made across the sequence of strata underlying the upper Römer band in mine Žofie, cross-cut 710/I. div. Stigmarian layers have been divided according to the content and deposition of root remnants as follows:

Aa1 — Separated appendices deposited only on lamination planes.
Ab1 — The same, but together with other vegetal remains.
Aa2 — Separated appendices deposited only in various directions.
Ab2 — The same, but together with other vegetal remains.
Aa3 — Separated appendices deposited both on laminations planes and in various directions.
Ab3 — The same, but together with other vegetal remains.
Ba1 — Separated appendices and roots with appendices deposited only on lamination planes.
Bb1 — The same, but together with other vegetal remains.
Ba2 — Separated appendices and roots with appendices deposited only in various directions.
Bb2 — The same, but together with other vegetal remains.
Ba3 — Separated appendices and roots with appendices deposited both on lamination planes and in various directions.
Bb3 — The same, but together with other vegetal remains.
Ca1 — Roots with appendices deposited only on lamination planes.
Cb1 — The same, but together with other vegetal remains.
Ca2 — Roots with appendices deposited only in various directions.
Cb2 — The same, but together with other vegetal remains.
Ca3 — Roots with appendices deposited on lamination planes and in various directions.
Cb3 — The same, but together with other vegetal remains.

As an illustration of the varied character of stigmarian rocks the writer presents the section across the sequence of strata underlying the upper Römer band in mine Žofie, cross-cut 710/I. div.

0— 0.62 m. coal seam
— 1.52 m. Ab1
— 2.06 m. Ab1 in coal shale
— 2.65 m. coal seam with two intercalations of coal shale
— 3.25 m. Ba2
— 3.46 m. Aa2
— 3.62 m. coal seam
— 4.72 m. Ba2
— 6.28 m. Ab1
— 6.56 m. barren rock
— 6.66 m. coal shale
— 6.81 m. barren rock
— 6.90 m. coal shale
— 7.12 m. Ba2
— 7.20 m. Aa3
—11.68 m. barren rock
—13.30 m. Ba2
—15.10 m. barren rock
—15.20 m. cannel coal
—15.32 m. coal seam
—16.44 m. Ba2
—16.72 m. Aa2
—17.26 m. Ba3
—17.44 m. Ba2
—17.81 m. coal seam
—18.60 m. Bb3
—18.90 m. coal shale
—19.14 m. Ab1
—20.— m. coal shale

This cross-section shows clearly that *the occurrence of stigmarian rocks is to a certain extent independent of coal seams and* that *the mode of deposition of roots and/or their parts differs in various stigmarian rocks as well as at different levels of one and the same stigmarian rock.*

Let us bear in mind that *the underclays of the Tertiary seams do not usually bear any root remnants.* The roots, if they are concentrated, usually accumulate directly in the lower parts of the seams. On the other hand, *the roots of some late-Paleozoic plants appear at any levels whatever in the lower divisions of cyclothems, they, however, accumulate most abundantly in the underclays.* The roots filled up with sand are sometimes frequent also in coarser sediments.

The difference in the character of stigmarian rocks may be made use of in correlation. The existence of regional and vertical changes in the character of individual stigmarian rocks suggests that the classification of stigmarian rocks in itself will not afford better bases for the correlation of cyclothems that the coal-petrography. Good results, however, could be arrived at by the combination of both methods.

ANALYSES OF THE UNDERCLAYS

An attempt has been made to ascertain whether or not the differences in the deposition of roots in various underclays are accompanied by differences in the composition of these sediments.

Some circumstances suggest that the stigmarian underclays cannot be considered subaerial soils in situ (*weathering and the fossilization of roots eliminate each other),* but law-adhering members of the graded lower divisions of the late-Paleozoic cyclothems. Because of that, the character of stigmarian rocks must be examined as carefully (both regionally and vertically) as the character of other sediments.

A series of samples were taken from the sequence of strata between seams Max and Gustav in mine Václav. Some of them were taken from different levels of one and the same underclay as well as from the partings. Each sample was subject to thermic and X-ray analyses. The former were made by D. Zbořilová, the latter by D. Kobzova.

The results of the analyses supplement those that have been acquired by the study of the deposition of roots in the underclays.

The X-ray analyses have shown that pelitic underclays have an illitic, illitico-kaolinic or illitico-sideritic character. Hence, they differ from each other. However, series of underclays of equal or very similar character frequently appear in a smaller or greater number of superimposed cyclothems. Of course, this phenomenon will render the correlation of individual underclays difficult. The difficulties in the correlation also increase because of the existence of levels somewhat different in character in some underclays.

The thermic curves, too, reveal differences in the character of various underclays as well as in the character of various levels of one and the same underclay. The courses of the curves are strongly influenced by phytogeneous matter. The influence differs according to the amount of phytogeneous matter in the underclays. In spite of that however (and to a certain degree for that very reason) the curves can elucidate the differences between the individual underclays and between their individual levels. Figs. 2-4 demonstrate the results of the thermic analyses of the samples from a succession of pelitic stig-

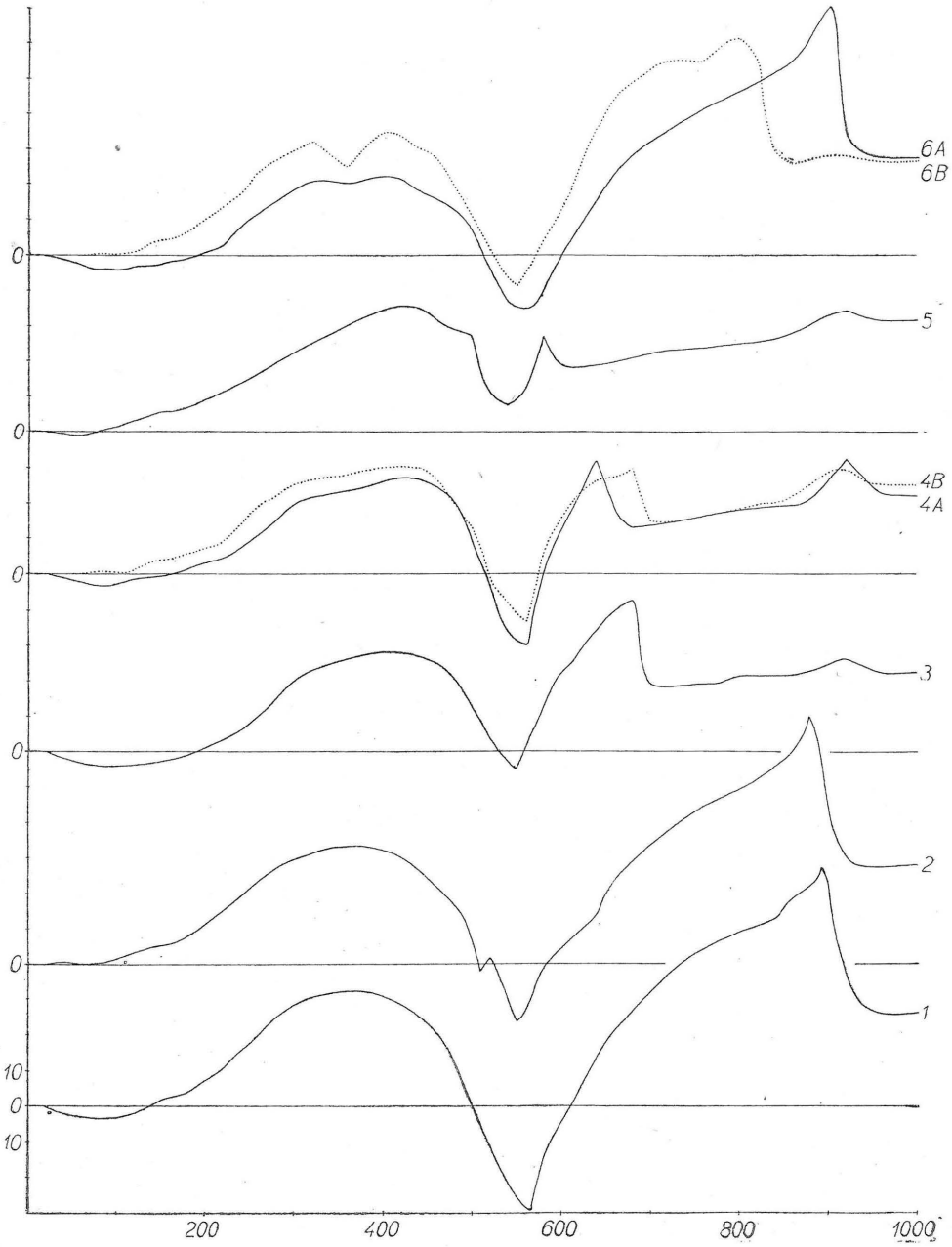

Fig. 2. Differential thermic analyses of pelitic underclays from the Poruba zone, mine Václav, 4th gallery, cross-cut to air-pit. Analysed by D. ZBOŘILOVÁ. **1**—0 to 20 cm. below seam Gustav. **2**—0 to 14 cm. below the lower thin seam underlying the Xth seam. **3**—underclay of the upper thin seam underlying the Xth seam. **4**—underclay of the Xth seam (**4A**—lower part, **4B**—the uppermost part). **5**—underclay of the Gabriela seam. **6**—underclay of the Sec seam (**6A**—from 6 to 27 cm. below the seam, **6B**—close below the seam.

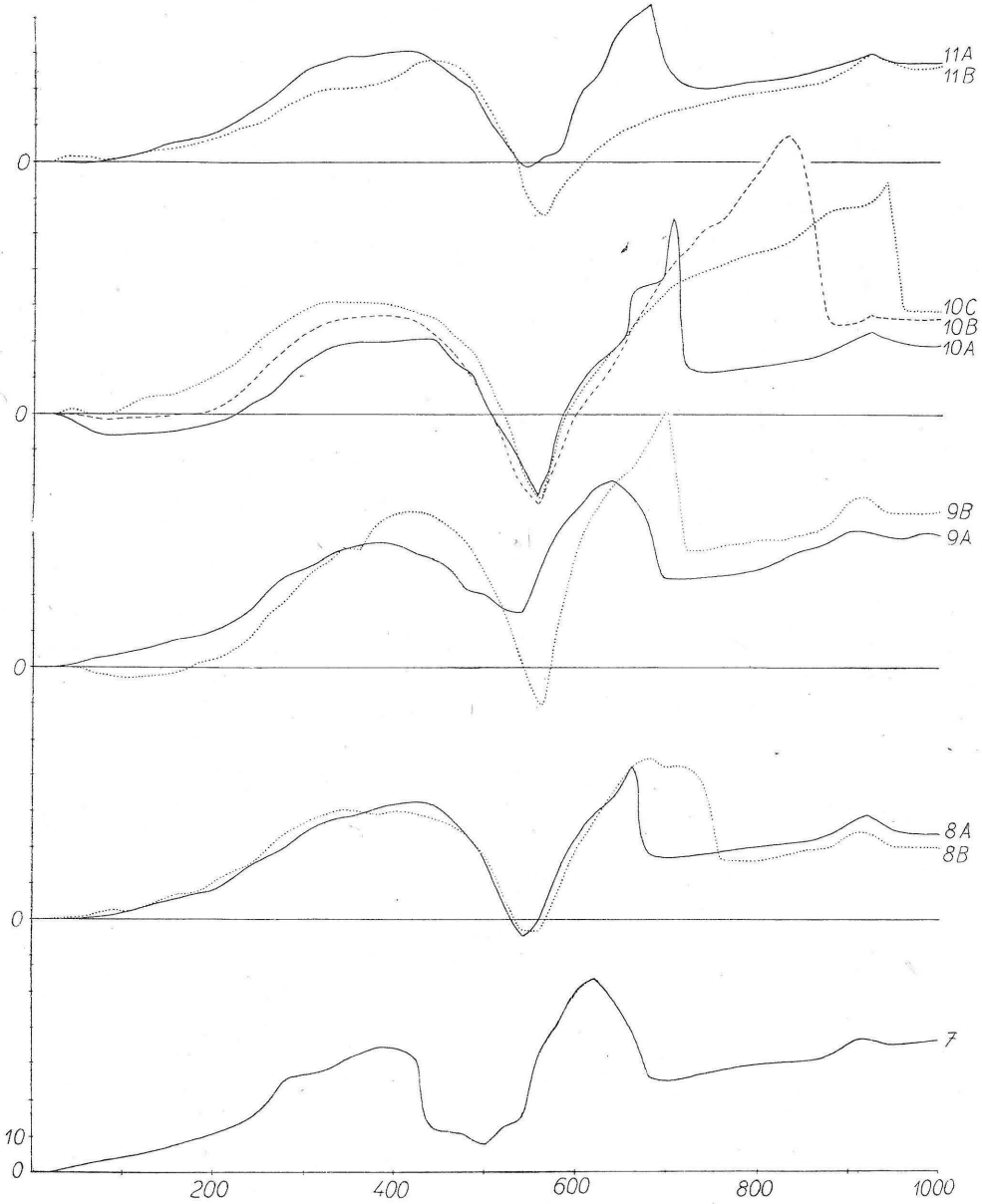

Fig. 3. Differential thermic analyses of pelitic underclays and partings from the Poruba zone, mine Václav, 4th gallery, cross-cut to air-pit. Analysed by D. ZBOŘILOVÁ. 7—45 cm. below seam Ivan. **8A**—0 to 5 cm. below seam Justin. **8B**—parting in seam Justin. **9**—underclay of seam Konrád (**9A**—136 cm. below the seam, **9B**—close below the seam). **10A**—80 cm. below seam Lothar. **10B**—0 to 8 cm. below seam Lothar. **10C**—lower parting in seam Lothar. **11**—underclay of seam Max (**11A**—32 cm. below the seam, **11B**—close below the seam).

marian rocks and from the partings in some coal seams in the Poruba zone (from seam Gustav up to seam Max). The thermic curves for the Gustav underclay (1), for the underclay of the nameless seam below seam X (2), for the Sec underclay (6A) and for the Lothar underclay (10B, C) greatly resemble one another. The thermic curves for the underclays of the other seams differ in character from the afore-mentioned. They, however, considerably resemble one another. The differential thermic analyses show, in principle, the same as the X-ray analyses do. The stigmarian rocks differ from one another. However, *series of underclays of equal or very similar character often appear in a succession of superimposed cyclothems.* On the other hand, the individual levels of one and the same underclay sometimes somewhat differ in character.

The whole lower divisions of cyclothems, including the underclays, must be subject to a further and complex investigation. First it is necessary to elucidate to what extent the regional and vertical differences in the character of sediments were caused by the mechanical differentiation of the material in the course of its deposition and to what degree

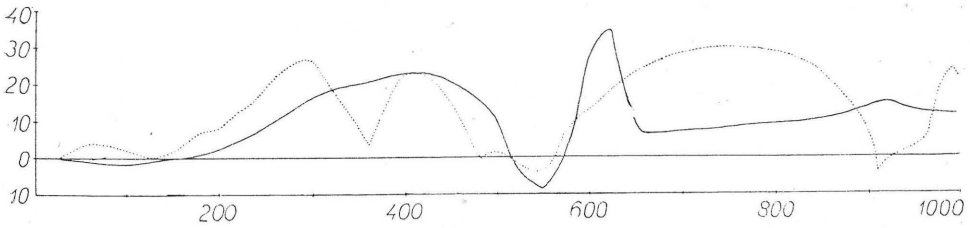

Fig. 4. Differential thermic curves for claystones, 0-11 cm. below the nameless thin seam between seams Konrád and Lotar, mine Václav, 4th gallery, cross-cut to air-pit. Full line—curve for underclay. Dotted line—curve for argillaceous infilling of Stigmaria ficoides. Analysed by D. ZBOŘILOVÁ.

the differences in the character were brought about by chemical processes and by the migrations due to the redeposition of the sedimentary material and to its sudden deposition in a new environment with different physical and chemical properties. It is necessary to take into account that *the particle-by-particle sedimentation is usually so slow that the sediment has time enough to acquire chemical stability already at the time of its deposition. As soon as the material has been suddenly transplaced and deposited in deeper waters with specific chemical and physical properties, some of its components may become labile in the new environment. The leaching, migrations, empoverishment or enrichment of certain zones by certain elements and compounds, the formation of concretions, etc., may be brought about.*

The X-ray and thermic analyses have also contributed to the elucidation of the genesis of underclays. The X-ray analyses of the underclay of the nameless seam between seams Konrád and Lothar (mine Václav, 4th gallery, N.W. cross-cut) has proved the illiticokaolinic character of this underclay. The X-ray analysis of the infilling of a root from this underclay has shown the illitico-sideritic character of this infilling. The thermic curves for the underclay and for the infilling of the root also differ (fig. 4). The allochthoneity of the root is also proved by the difference in appearance, seen by the naked eye, between the infilling of the root and the underclay.

One may conclude that both *the deposition of roots and the analyses of underclays prove that the stigmarian rocks in the Ostrava part of the Upper-Silesian foredeep are not soils with autochthonous roots. The study of the subaerial-weathered and unweathered Carboniferous rocks from the Ostrava-Karviná coal district has lead to the same conclusion* (A. Přibyl—B. Růžička—M. Vašíček, 1956).

The results of spectral analyses of underclays by M. Bouberle are worth mentioning. Magnesium has been found in all the underclays. The history of the identification of the presence of this element in coal-bearing sediments is interesting. Some time ago, M. C. Stopes and D. M. S. Watson (1908) pointed out that the source of the magnesium in the so-called dolomitic concretions from coal seams could not be anything but sea water. Some students have recently tried to identify cyclothems with marine bands

by ascertaining magnesium in coal seams. Magnesium has been found in the coal seams underlying marine bands. It was inferred that marine influence (Marine Beeinflussung) may be proved by the find of magnesium in the seam without any search for a marine band in its roof. The joy at this discovery was very short-lived. H. W e r n e r (1954) has proved in the Ruhr-district a high content of magnesium in all the seams even when they lie below the fresh-water fauna bands or in the beds without faunal bands. The investigation of the underclays in the Ostrava beds has proved the presence of magnesium also in these rocks.

If magnesium in coal seams and underclays comes from the Carboniferous sea waters, its occurrence is not in harmony with the ideas of the paralic nature of the sedimentation spaces in which these sediments were deposited.

SUBAERIAL SOILS

If the seams of the Ostrava beds were autochthonous, underclays would more or less often pass laterally into subaerial soils.

The writer found, *in the Ostrava beds, only a single trace of subaerial weathering in the basement of the Zámek conglomerate* in the hereditary gallery of mine P. Cingr II. Only the lowermost part of the soil profile is preserved. The Zámek conglomerate is underlain by a seam of a greatly variable thickness. According to O. M a l á n (personal communication), all the vegetal remains in this seam are strongly corroded. The seam is underlain by a layer about 20 cm. thick of ochrous sandy loam without vegetal remains. This loam rests on a compact black-gray claystone.

The Jaklovec zone terminates in the afore-mentioned soil. A stratigraphical hiatus (floristic break) has been ascertained between this zone and the roof (the Poruba zone).

Subaerial soils have not been found so far at any other level of the Ostrava beds.

Later subaerial soils appear in the Karviná beds (the Saddle zone). They have been investigated (P ř i b y l—R ů ž i č k a—V a š í č e k, 1956). The results of this investigation have brought a series of facts elucidating the genesis of cyclothems of the Ostrava type.

EXPERIMENTS AND OBSERVATIONS ELUCIDATING THE ORIGIN OF CYCLOTHEMS OF THE OSTRAVA TYPE

A more or less perfect or interrupted gradation of material and/or a progressive increase in lighter both inorganic and organic material up to the roof of the seam may be observed in the simply and completey developed lower divisions of cyclothems of the Ostrava type. That suggests the question whether such a graded bedding may be produced by one and the same turbidity current.

In order to elucidate this problem, the following experiment was made: Material consisting of coarse and fine sand, loam, algae and leaf fragments of water plants was stirred up in a large aquarium. The material always came to rest in the following succession: coarse sand at the base grading up into a finer and finer material to a clean-cut bedding plane which was overlain by a layer of algae. Then a new sharp bedding plane followed, on which clay suspended in the water and some heavier leaves very slowly came to rest. This succession of material corresponds to that in the lower divisions of simple (not interferential) cyclothems. *In the case of the two-phase development of cyclothems, the sediments of evolutionary origin (sediments deposited particle-by-particle) may only be looked for as high up as above the clayey roof of the seam.*

Attention has been paid to the regional sorting of material in further experiments. A series of variations are possible. The complete lower divisions of cyclothems may originate only sometimes, in the places where the flow allows the deposition of all fractions. Every acceleration or slackening of the flow may in places bring about the absence or repetition of some material in the vertical profile across the lower division of a cyclothem.

Lamination often occurs in the lower divisions of cyclothems. The lowermost portions of the well-developed lower divisions are usually textureless; the simple parallel lamination often follows sooner or later and the waved and current laminations (sometime even cross bedding) appear higher up. These sorts of lamination usually pass again, in the fine material of the upper portions of the lower divisions of cyclothems, into the parallel lamination, which is often indistinct. It is visible only after weathering, or determinable according to the mode of deposition of vegetal matter.

The described succession of sedimentary microtypes in the lower divisions of cyclothems corresponds with successions that frequently occur in the coarser-material intercalations in Flysh sediments. A series of documents prove that these intercalations have been deposited from turbidity currents.

It is difficult, if not impossible, to carry out in a laboratory such experiments as to elucidate the causes of the origin of waved and current laminations. It is probable that

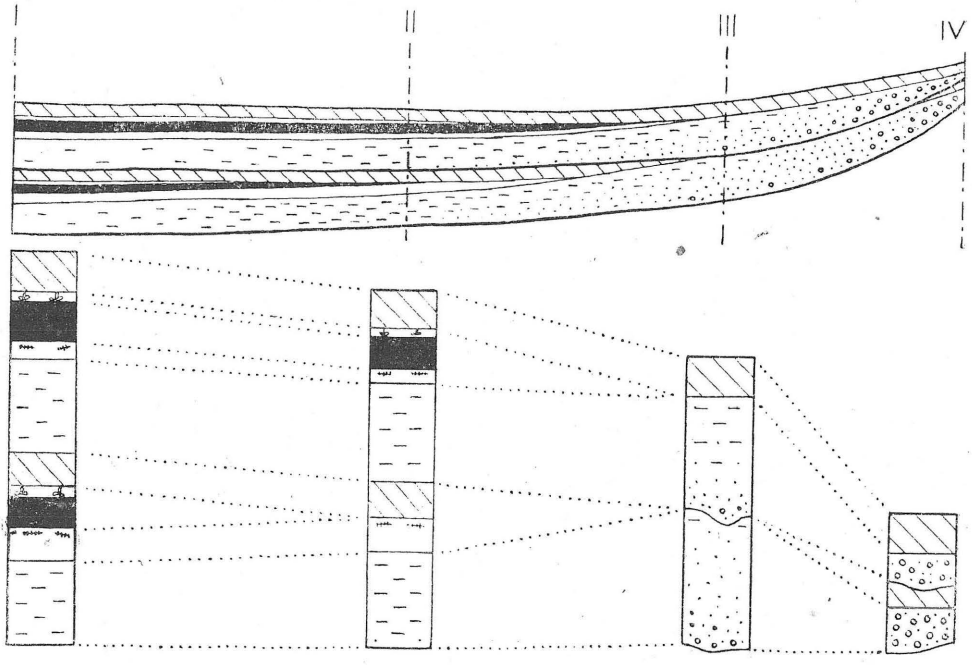

Fig. 5. Scheme of the two possible modes, from many others, of distribution of individual kinds of material in cyclothems, showing incomplete development of cyclothems in some facies.

stricture phenomena (mosaic differentiation of the flow and current—and/or cross-bedding of the material deposited) also occur in the case of turbidity currents, most frequently at later stages of their development after the reduction of their volume or when a certain ratio between their volume, velocity, and the amount and sort of their load was reached.

Experiments and observations elucidating the origin of two-phase cyclothems must continue chiefly in order to elucidate and prove the causes and conditions of various modes of the deposition and concentration of root remnants and to elucidate the modes of the deposition of varied vegetal material (peat, wood, leaves, etc.) together with inorganic material. It was already F a y o l who proved that parts of roots usually have a greater specific gravity and so must come to rest earlier than many other vegetal remains. Roots are sometimes accumulated in the basal parts of coal seams of Tertiary age. In the Paleozoic sediments root remnants are chiefly accumulated in underclays, while they are rare in the deeper portions of cyclothems and in the seam proper. That points to a greater specific gravity of stigmarias than that of the roots of the Tertiary (and also Recent) coal-producing plants. Because of this fact, laboratory experiments trying to elucidate the origin of the Paleozoic cyclothems of the two-phase type will be difficult.

CONCLUSION

Every complete cyclothem of the Ostrava type is formed of two divisions. In the lower division of a complete cyclothem it is usually possible to observe a simple or intricate gradation of inorganic and organic material from the base up to the roof of the seam. Sands containing stumps, trunks and roots filled up with sand and sometimes also remnants of some tree barks are usually deposited at the base. These sands are followed upwards by fine sands and sandy claystones, in which plant remains of medium weight are most often deposited. These remains are especially calamites, which presumably had, like the present *Equisetum,* a considerable specific gravity owing to silica in their cellular membranes. A great concentration of root remnants without sandy infillings, which are here and there accompanied by another flora, first of all by calamites, appears in the relatively finest tops of these rocks. Then the seam follows. It is usually formed only of fragments of plant tissues. The seam in sometimes overlain by fine clay, which occasionally encloses well preserved light plant remnants, first of all leaves. This fine clay or the seam terminates the lower division of the cyclothem.

Regional extents of individual members of the lower division of a cyclothem are usually diverse. Some members may be missing in some places (so e. g. sometimes there is no accumulation of roots below the seam, or the underclay is not overlain by a seam, at another place there is no coarse sandy material at the base of a cyclothem, etc.). On the other hand, it also happens that some members of the lower division of a cyclothem perceptibly or imperceptibly recur. A perceptible recurrence is, e. g., some twin-seams, inversion of gradation, etc. A whole series of facts point to a sorting of material and to changes in distances in the course of deposition of the lower divisions of cyclothems, in which a certain kind of the sorted material could have settled. The lower division of every cyclothem is thus a unit that was built up of material sorted and deposited in accordance with the flow and its changes. For this reason, *the lower divisions of cyclothems must be investigated as a whole because only so it is*

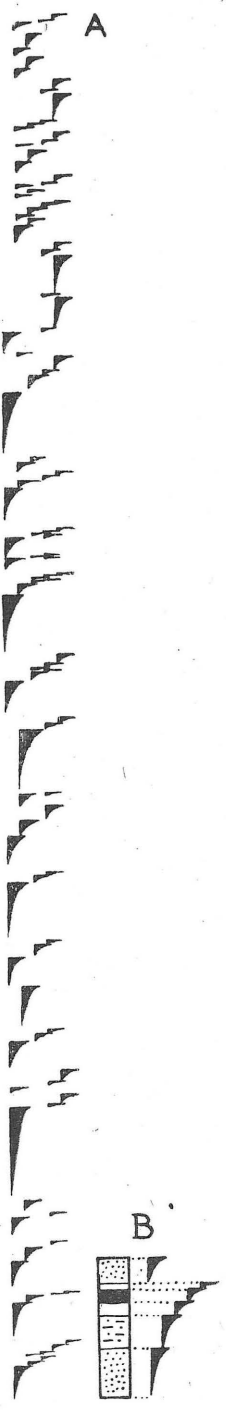

Fig. 6. A—cyclogram of the upper part of the Petřkovice zone (from cyclothem of the Poustevník seam up to wettstein), just as it is developed in mine František. Cyclogram shows clearly positive gradation of the material of cyclothems. B—mode of the construction of a cyclogram.

possible to forecast more reliably the development of cyclothems in the adjacent areas and render the identification more precise.

The upper division of every complete cyclothem of the Ostrava type strikingly differs from the lower and obviously arose under quite different sedimentation conditions. This division does not possess gradation of material, apart from exceptions to follow below. The upper division is formed of barren claystones, bearing intercalations of another material and/or smaller cyclothems. Only these intercalations sometimes show gradation or other phenomena reminiscent of a swift sedimentation. The modes of occurrence and preservation of the fauna also belong among these phenomena. The fauna appears in intercalations, which have very diverse faunal contents and regional extents. Almost all bivalve shells are complete; the infillings of cavities are of another matter than the rock in which they are deposited. As shown by experiments and observations, bivalve shells cannot in bulk be preserved complete and firmly closed in particle-by-particle sedimentation. All the less can the cavities of such shells be filled up with material that differs from the sediment in which the fossils are embedded. Modes of the occurrence of fossiliferous bands also correspond to the allochthoneity of fossils, which is also proved by joint occurrence of diversely fossilized remains of organisms. Such bands appear in the upper divisions of cyclothems as intercalations in the barren pelites. The number and thickness of these intercalations often strongly vary regionally. Some of them have small local extents. Others extend over an extensive area. However, one may often ascertain that the extensive bands are formed of locally developed layers (often with a different fauna) so that they rather indicate spaces of time that are favourable for the redeposition of sediments with organic remains into deeper waters with unfavourable life conditions than the spaces of time favourable for the growth of organisms in the areas where such bands are situated. In accord with these phenomena, exacting marine organisms suddenly appear, or disappear, at the bases or in the roofs of fossiliferous bands (layers). The same applies to the mixtures of marine and fresh-water fauna and flora.

This information has elucidated the causes of the failure of earlier authors in the correlation of profiles by faunal contents. The correlation of individual bands, and in some cases of groups of bands at least, is however feasible. Of course, it is not possible to correlate by a mechanical comparison of species. As shown by experiences from other formations, pseudoassociations may vary from place to place. The lower boundaries of the occurrences of animal species remain valuable. And also those phenomena are valuable that were brought about by fossilization after a definite deposition. Less important, nevertheless applicable criteria are the pseudoassociations with fossils bleached out through weathering that appear in abundance above and below stratigraphical hiatuses as well as above and below sequences of strata containing many fresh-water-fauna bands, that is at the levels accompanying greater changes in the topography of the basin. The case is better in the correlation with the help of flora, because fossil remains cannot well stand a transport and well preserved remains may be regarded to be practically contemporaneous with the sediment in which they are embedded.

The present three years' work has afforded on the whole a true picture of possibilities and difficulties in the correlation by comparing the upper divisions of cyclothems, in which faunal and rarely also floristic bands—their most valuable elements—appear as separate intercalations. Therefore, they may be correlated isolately, separately from the other sediments of the cyclothems. As before said, the case is different with the lower divisions of cyclothems. Only experiences with the correlation of seams and their partings have been acquired there for the present. Though this correlation has afforded many good results, better and more reliable results may be expected if the seams are not separated from the lower divisions of cyclothems, which are natural units. Therefore, we may strongly recommend that the petrological investigation of seams should be accompanied by the examination of the dependence of their development on the other sediments of the lower divisions of cyclothems.

In co-operation with A. P ř i b y l and B. R ů ž i č k a (1956) the boundaries of some zones have been adjusted so as to correspond to natural boundaries. The upper boundary of the Jaklovec zone has been shifted as high up as the base of the Zámek conglomerates, where a smaller floristic break appears. In the basement of these conglomerates a layer of subaerial soil was found in the hereditary gallery in mine P. Cingr II. This soil proves the shifting to be correct. Consequently, of course, the Jaklovec zone terminates in "seamless" sediments, just as the Hrušov zone does. The upper boundary of the Poruba zone has been shifted as high up as the roof of seam Prokop, where the Prokop cyclothem terminates.

Such more naturally delimited zones show numerous analogous evolutionary features, e. g. the location of bands containing strongly silicified and leached-out fossils into the middle beds of individual zones, the presence of fossils attacked by weathering in the upper and lower beds of individual zones, and the like.

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