

# A GONIATITE FAUNA FROM THE VISÉAN/NAMURIAN BOUNDARY

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ABSTRACT. A section spanning the Viséan/Namurian boundary is described from the eastern part of the Rheinisches Schiefergebirge, Germany. The goniatites, mostly belonging to the genus *Eumorphoceras*, have enabled the boundary between Upper and Lower Carboniferous strata to be positioned within 50 cm.

IN 1960 the stratigraphical subcommission on Carboniferous stratigraphy of the International Geological Congress (Part 28, pp. 284–90) accepted the following resolution: '7. The Subcommission proposes, that . . . the strata containing the earliest occurrence of *Cravenoceras leion* Bisat be taken for the present as the base of the Namurian. . . .' This resolution ended nearly thirty years of controversy and the compulsory biostratigraphical scheme is now as follows:

Zone of the <i>Eumorphoceras pseudobilingue</i> <i>Cravenoceras leion</i>	$E_1$
Zone of the <i>Goniatites schaelkensis</i>	$Goy_1^2$
Zone of the <i>Goniatites granosus</i>	

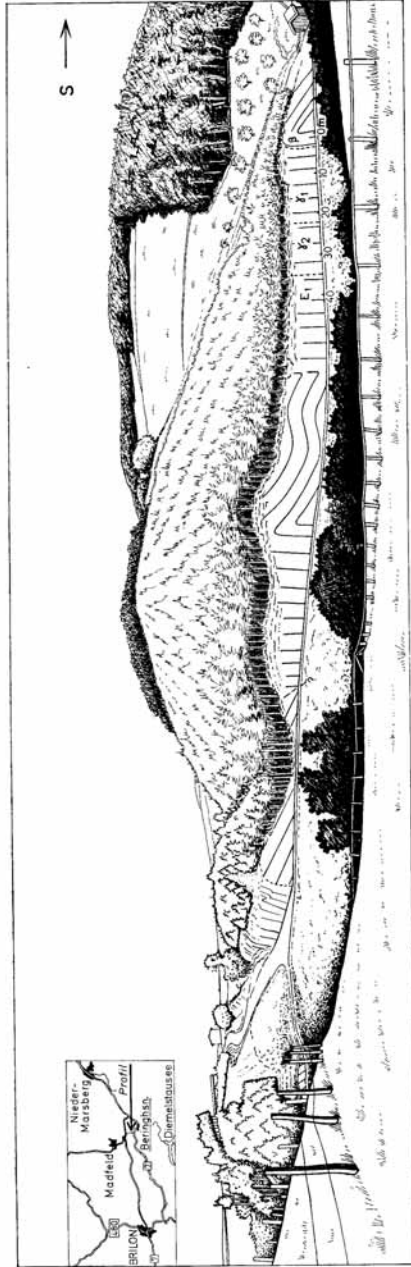
Since a section with a complete and uninterrupted succession of these strata is very rare in Germany, a description of one which allows the boundary between the Viséan and the Namurian to be placed within a range of 50 cm. seems to be justified. Furthermore, it can be expected that important parts of the exposure may be covered with refuse within a short time.

## STRATIGRAPHY

*Situation of the section.* Some hundred metres west of the village of Beringhausen (sheet 4518, Madfeld, 1:25 000 map of Germany) a small road turns off the 'Bundesstrasse 7' to the north in the direction of the village of Madfeld. About 150 m. north of the turning the road cuts across Carboniferous strata which yielded the fauna here described (point R 34 82 200, H 56 97 670, sheet 4518, Madfeld) (fig. 1).

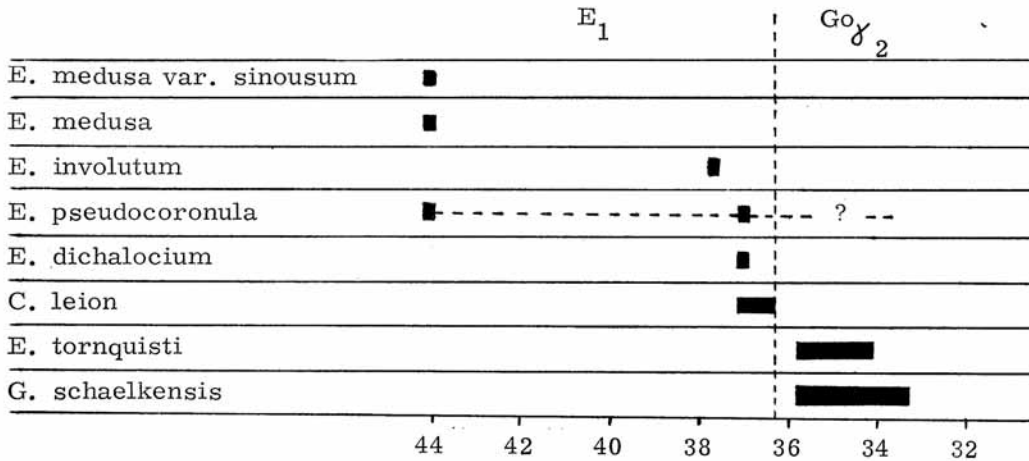
The section begins in the core of an anticline overturned towards the north, stratigraphically belonging to the upper  $Goy_1$  zone. To the north a disturbed syncline abuts the anticline. Its northern flank—dipping 45° SE.—is exposed about 250 m. further north in a refuse pit at the point R 34 82 140, H 56 97 800. It is mainly from here that the well-preserved fauna has been obtained. Lithologically the rocks are shales with a rather high calcareous component in the basal parts, sometimes even grading into true limestone. In the upper part, however, an increasing arenaceous component passes up into 'Streifenschiefer', that is, rocks with a more or less regular alternation of shales and thin beds of greywacke. These greywackes are the first indications of the deposit of the coarse-grained clastics of the lower 'Flözleeres' beginning in this area somewhat later in the Namurian (Wachendorf 1965, p. 712).

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TEXT-FIG. 1. Section of the Carboniferous strata west of Beringhausen (Eastern Rheinisches Schiefergebirge).

*Biostratigraphical succession.* The lowermost faunal band containing *Goniatites striatus falcatis* (Roemer) has been found near the refuse pit of Beringhausen. The higher subzones of the  $Go_{\beta}$  zone could not be proved, but only little attention was paid to them since they are of less value for the outstanding problem. In regard to the  $Go_{\beta}/Go_{\gamma}$  boundary the statement of Ruprecht (1936, p. 241) and Hermann Schmidt (1942, p. 54 and pl. 1, fig. 4) was confirmed. Two alum shale beds, the so-called 'Actinopteria beds', containing abundant specimens of the lamellibranch *Pteronites lepidus* Goldfuss represent the characteristic key horizon of the lower  $Go_{\gamma 1}$ .



TEXT-FIG. 2. Goniatile fauna of the Viséan/Namurian boundary from exposures in the road-cutting west of Beringhausen at the distances shown (see text-fig. 1).

The name 'Actinopteria beds' originates from a former denomination of the lamelli-branch *Actinopteria persulcata* McCoy and is still used in Germany as a definite stratigraphical term of long standing.

In the lower part of the  $Go_{\gamma 1}$ , *Neoglyphioceras subcirculare* is abundant. It is gradually replaced by *Goniatites granosus* without any sharp boundary between them. Their vertical interfingering can be well observed in other areas, too (Figge 1964, p. 776).

Unfortunately the boundary between the  $Go_{\gamma 1}$  and  $Go_{\gamma 2}$  subzones is not exposed. There is a gap of about 7 m. between the uppermost *Goniatites granosus* band and the lowermost *Goniatites schaelkensis* band. The index fossil of the  $Go_{\gamma 2}$ , *Goniatites schaelkensis*, is associated with *Eumorphoceras tornquisti* and a questionable *Eumorphoceras pseudocoronula*.

The base of the Namurian is marked by the first occurrence of *Cravenoceras leion*, its lowermost occurrence being 50 cm. above the highest *G. schaelkensis* bed. 75 cm. above the earliest *Cravenoceras leion*, *E. pseudocoronula* and *E. dichalocium* have been found; the latter being apparently restricted to this single horizon at the base of the Namurian. Its great similarity to *E. tornquisti* and its stratigraphical position indicate its evolution from *E. tornquisti*, probably as a link to *E. pseudocoronula*.

This fauna is overlain by beds containing *Peytonoceras? involutum* and further above by the *Eumorphoceras medusa* forms described by Yates in 1961. The latter were proved for the first time in Germany, obviously in the same stratigraphical position as in Ireland (Yates 1962, table 1). In spite of an intensive search not a single specimen of *E. pseudo-bilingue* could be found in the overlying arenaceous 'Streifenschiefer'.

Bisat (1950, p. 12) doubting the independence of *G. schaelkensis* supposes that it might be a form of *C. leion* or *Sudeticeras* or *Lyrogoniatites tonksi*. The species described here as *Goniatites schaelkensis*, however, differs distinctly in its form and stratigraphical position from the other species, so that its independence cannot be doubted.

#### SYSTEMATIC DESCRIPTIONS

All specimens are preserved as shale impressions. Many of them are tectonically distorted parallel to the B-axis. Proportional numbers given in the following resulted from measuring at an angle of 45° between the longest and the shortest axis of the fossil. In this direction any mistake originated by distortion can be neglected.

The fossils described are housed under the registration numbers mentioned in the Museum of the Department of Geology of the University of Göttingen.

#### *Goniatites schaelkensis* (Brüning)

Plate 47, figs. 5, 6

1923 *Paraglyphioceras schaelkense* Brüning, p. 29, figs. 8e, 9e.

*Material.* Seven specimens, partly fragmentarily preserved (nos. 573:1 to 7).

*Diagnosis.* Rather involute *Goniatites* with simply curved growth-lines being bent backwards completely. Spiral striation is indicated by a crenulation of the growth-lines.

*Description.* The conch seems to be rather broad. The ratio of the diameter to the width of the umbilicus is on an average 6:1, in the largest specimen it amounts to 7:1. The umbilical wall is steep, the umbilical edge moderately rounded.

Near the umbilicus the growth-lines are directed forward. But very soon they turn back running into a smooth, backwardly directed bow across the flanks and the venter. In several specimens a periodical thickening of the shell has been observed, mainly on the dorsal half of the flanks. There are between the thickenings about five growth-lines. At first glance only these thickenings can be seen, the very fine growth-lines are usually not so distinct.

Microscopically a crenulation of the growth-lines indicating a spiral striation can be seen. This crenulation, however, is absent in *Cravenoceras leion*. Following Brüning (1923, p. 29) *G. schaelkensis* can be easily recognized by this crenulation and its convex growth-lines.

*Discussion.* Bisat (1950, p. 12) suspects that different species are grouped together under the term *G. schaelkensis*, viz. a form of *Sudeticeras*, *Cravenoceras leion*, and *Lyrogoniatites tonksi*. This concept, however, does not apply to my material or that of the Museum of the Department of Geology of the University of Göttingen. *Cravenoceras*

*leion* has absolutely straight growth-lines without any crenulation or even spiral-striation. *G. schaelkensis*—on the contrary—has clearly curved and crenulated growth-lines. All species of *Sudeticeras* which I have seen so far show indications of spiral-striation, mainly near the umbilicus and the lingua.

Furthermore, the growth-lines of *Sudeticeras* always show a lateral—though sometimes rather small—salient. Also the stratigraphical range does not support the idea of Bisat.

*Occurrence.* Go<sub>2</sub>.

*Eumorphoceras (Edmooroceras) tornquisti* (Wolterstorff)

Plate 46, figs. 1-3

1899 *Dimorphoceras? tornquisti* Wolterstorff, p. 34, pl. 2, figs. 12-14.

*Material.* Eleven specimens (nos. 573:8 to 18).

*Diagnosis.* *Eumorphoceras* with a rather narrow umbilicus, sickle-shaped growth-lines, and short comma-shaped deepenings near the umbilicus. Lateral furrow not divided into two.

*Description.* *Eumorphoceras tornquisti* is characterized by its relatively narrow umbilicus, somewhat resembling *Girtyoceras* from which it probably evolved (Yates 1962, p. 367; Gordon 1964, p. 228). The ratio of the diameter to the width of the umbilicus remains rather constant during the different growth-stages and amounts to 5:1. The umbilical edge is slightly raised, the resulting rim, however, does not appear as strong as in *E. pseudocoronula*.

The growth-lines leave the umbilicus in a forward direction but turn back very soon. About in the middle of the flank they bow forward again forming a salient on the shoulder. The ventral sinus is deep.

*E. tornquisti* has short, comma-shaped deepenings around the umbilicus, about six per half whorl (573:12). No constrictions can be observed.

While in all species of the genus *Eumorphoceras* the lateral furrow is divided into two by an intermediate ridge—the ventral furrow is often much shallower—*E. tornquisti* has only a single furrow, as described by Wolterstorff (1899, p. 35, and pl. 2, figs. 11-14) in the type description. In contrast to this, the furrow in the stratigraphically younger *E. dichalocium* is always clearly divided into two. Since these species have not yet been properly separated it can be often read that *E. tornquisti* has a divided furrow.

*Discussion.* Elias (1956, p. 132) erected *Edmooroceras* as a subgenus of *Eumorphoceras*, describing as one of the main features a 'subangular and nodose umbilical edge'. Horn (1960) regarded these features as so important that he placed *E. tornquisti* and, like Elias, *E. pseudocoronula* in this subgenus. Yates (1961), however, for certain reasons, preferred to retain these species as *Eumorphoceras sensu stricto*. It should be the object of a special investigation, including a reappraisal of the type specimens, to decide whether these features justify a subgenus. Until this has been done the subgenus *Edmooroceras* erected by Elias is valid and therefore is still used here.

*Occurrence.* Go<sub>2</sub>.

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*Eumorphoceras* (*Edmooroceras*) *dichalocium* sp. nov.

Plate 46, figs. 5-7

*Derivatio nominis.* Greek: δίχα = double, ἄλοξ = furrow.

*Holotype.* No. 573:19.

*Paratypes.* Nos. 573:20 to 22.

*Diagnosis.* Very closely related to *Eumorphoceras tornquisti*, but with a division of the lateral furrow into two and slightly longer constrictions in the umbilical region.

*Description.* This new species which is very similar to *E. tornquisti* has been found at the base of the Namurian associated with *Cravenoceras leion*. As in *E. tornquisti* the umbilicus is relatively small. In the holotype the ratio of the diameter to the umbilical width amounts to 5:1. The umbilical edge is raised into a rim as is characteristic of the subgenus *Edmooroceras*. Especially in the smallest specimen there is to be seen a slight beading of the rim. The growth-lines are sickle-shaped, forming a high lateral salient on the shoulder and a sinus of equal depth on the venter. Around the umbilicus there are regular constrictions running parallel to the growth-lines and dying out just before they reach the middle of the flank. Compared with the comma-shaped deepenings in *E. tornquisti* specimens of equal size they are slightly longer.

The well-pronounced lateral furrow is divided into two by a strong ridge. The ventro-lateral groove is little shallower than the dorso-lateral one.

*Discussion.* The close relationship of this new species with *E. tornquisti* has been pointed out repeatedly. The occurrence of a divided lateral furrow in contradistinction to the single furrow in *E. tornquisti* is a diagnostic feature and justifies the separation of both species. The other differences, such as the longer constrictions and the somewhat higher lateral salient are of more subtle nature. Therefore, *E. dichalocium* seems to grade phylogenetically between *E. tornquisti* and *E. pseudocoronula* and this is also indicated by its stratigraphical position. Since *E. dichalocium* has been previously included with *E. tornquisti*, the latter was considered to have a greater stratigraphical range (according to Horn 1960, *E. tornquisti* is associated with *Cravenoceras leion*). In the section described here *E. tornquisti*, however, does not reach the base of the Namurian whilst *E. dichalocium* lies just above the base.

Moore (1946, p. 418) described a *Eumorphoceras* sp. form A which he places also between *E. tornquisti* and *E. pseudocoronula*. This form seems to be similar to *E. dichalocium*. Moore, however, did not mention any constrictions and only shallow lateral double-furrows. Nevertheless it cannot be excluded that these differences are due to the state of preservation and both species may turn out to be identical. There is no similarity between *E. dichalocium* and *Sagittoceras costatum* Ruprecht which has a much stronger sculpture.

*Occurrence.* E<sub>1a</sub>.

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*Cravenoceras leion* Bisat

Plate 47, fig. 4

1930 *Cravenoceras leion* Bisat, p. 28, fig. 1.*Material.* Seven partly fragmentary specimens (nos. 573:23 to 29).*Diagnosis.* Rather broad form with numerous very fine and straight growth-lines.*Description.* Even from the shale impressions it can be concluded to be a rather broad shell. The umbilicus is moderate in size. The sculpture consists of very fine and tight growth-lines. Horn's statement (1960, p. 334) that there are about 5-7 lines per mm. in the middle of the flanks has been confirmed. In the smaller specimens there are probably even more.

The growth-lines leave the umbilicus in a slight forward direction but after a very short distance they bend into a radial direction crossing the flanks and the venter completely straight. No indication of spiral striation could be found and no crenulation of the growth-lines was observed.

The absence of spiral sculpture, the very straight direction of the growth-lines and their delicacy are the most important features of *C. leion*.*Occurrence.* E<sub>1a</sub>.*Eumorphoceras (Edmooroceras) pseudocoronula* Bisat

Plate 46, figs. 8-9

1950 *Eumorphoceras pseudocoronula* Bisat, p. 19, pl. 2, fig. 4.*Material.* Ten partly fragmentary specimens (nos. 573:30 to 39).*Diagnosis.* Because of the raised umbilical edge these belong to the subgenus *Edmooroceras*. In youth the sculpture consists of short ribs which become shorter with increasing age until they are only knots. Regular constrictions are present. They form a high lingua and run parallel to the growth-lines.*Description.* The umbilicus is widened in youth; with increasing age, however, it becomes smaller. At a diameter of 8 mm. the ratio diameter to the width of the umbilicus amounts to 2:1, at 16 mm. nearly 3:1 (specimen no. 573:32). Contemporaneously the ribs fade more and more and at a diameter of 10 mm. they can be seen only as knots on

## EXPLANATION OF PLATE 46

Figs. 1-3. *Eumorphoceras (Edmooroceras) tornquisti* (Wolterstorff), Go<sub>2</sub>. 1. No. 573:8. 2. No. 573:17. 3. No. 573:18.Fig. 4. *Peytonoceras? involutum* (Horn), E<sub>1a</sub>, no. 573:40.Figs. 5-7. *Eumorphoceras (Edmooroceras) dichalocium* sp. nov. E<sub>1a</sub>. 5. No. 573:19. 6. No. 573:20. 7. No. 573:21.Figs. 8-9. *Eumorphoceras (Edmooroceras) pseudocoronula* Bisat. E<sub>1a</sub>. 8. No. 573:30. 9. No. 573:31.

the raised umbilical edge. I wrote in a former paper (Figge 1964, p. 778) that the number decreases continuously. This could not be proved with the present material since the shale impressions do not show the inner whorls. This observation, however, may hold true here, too, because the knots on the umbilical edge are much wider spaced, sometimes even disappearing in the adult specimens. A striking feature of *E. pseudocoronula* are the regular constrictions. They are bordered on each side by marked edges, the distal one being often raised. Between two constrictions there are mostly two short riblets which start on the umbilical edge and fade out on the middle of the flanks. In adult specimens these riblets are represented only by knots on the umbilical edge. The constrictions leave the umbilicus radially, but in the middle of the flank they bend forward in a smooth bow forming a high salient on the shoulder. The ventral sinus is not as deep as the salient. The depth of the constrictions decreases in the region of the salient. On the venter they are often scarcely visible.

The furrow on the shoulder is divided by a marked ridge into a dorso-lateral groove and a slightly shallower ventro-lateral one. The constrictions divide the ridge into longish knots.

Owing to the raised umbilical edge this species has to be placed in the subgenus *Edmooroceras* (Elias 1956).

*Discussion.* *E. pseudocoronula* is well characterized by the regularity and the form of its constrictions. Therefore it can be hardly mistaken for another species. The strongly ribbed youth-form, however, resembles *E. pseudobilingue*. There are also relations to *E. medusa* which represents a later stage of evolution of *E. pseudocoronula* (Yates 1961, p. 54).

*Occurrence.* E<sub>1a</sub> (Lower Namurian).

*Peytonoceras? involutum* (Horn)

Plate 46, fig. 4

1960 *Eumorphoceras? involutum* Horn, p. 330, figs. 4–5, pl. 1, figs. 3–5.

*Material.* One specimen (no. 573:40).

*Diagnosis.* Very involute, with a clearly marked double-furrow and sickle-shaped growth-lines.

*Description.* Horn (1960) and Yates (1961) describe a very involute *Eumorphoceras* from the *Cravenoceras leion*-bearing beds of the lower Namurian. The umbilical edge is not clearly marked, the flanks curve gently to the umbilicus.

The prominent shoulder ridge together with the minute umbilicus is typical of *Peytonoceras? involutum*. This strong and narrow ridge divides the lateral furrow into a dorso-lateral and a ventro-lateral one of equal depth. Yates made the same observation, whilst Horn described the ventral groove as being shallower. Judging from Horn's paratypes this difference might well be caused by the state of preservation.

The sculpture consists of very faint growth-lines which are little prominent near the lingua. After leaving the umbilicus radially, they bend back before they turn forward close to the shoulder forming a high lingua. The depth of the ventral sinus is not visible. There are no constrictions.



*Discussion.* *P. ? involutum* (Horn) is obviously a synonym of *E. rota* Yates, but Horn has priority. The relationship between *Peytonoceras ? involutum* and other species, viz. *Eumorphoceras* sp. form A of Moore, *Sagittoceras costatum* Ruprecht etc. has been discussed by Horn and Yates. Both authors concluded that *P. ? involutum* is an independent species.

Saunders introduced a new genus *Peytonoceras* which he described as follows (1966, p. 43): 'The genus *Peytonoceras* is characterized by a subdiscoidal, involute conch with a narrowly rounded venter and sharply sculptured lateral grooves or sulci. Conch sculpture, in addition to the narrow ventrolateral grooves, includes sinuous lateral ribs and extremely fine spiral lirae on the flanks.' And: 'In some respects *Peytonoceras* is morphologically similar to *Eumorphoceras*. These similarities include ventrolateral grooving and lateral ribbing, which are features shared by all species of *Eumorphoceras*. *Peytonoceras*, however, is involute beyond the third or fourth whorl, whereas *Eumorphoceras* remains evolute to the fifth whorl in most cases. The narrow, deep ventrolateral groove of *Peytonoceras* is a feature shared by few, if any, species of *Eumorphoceras*, which may have two ventrolateral grooves separated by a ventrolateral ridge. Where only one groove is present, as in *E. bisulcatum*, it is shallow and wide. The external suture serves to distinguish *Peytonoceras* from some species of *Eumorphoceras*.'

Since no sutures are preserved either in the specimen 573:40 or in Horn's material, *P. ? involutum* can be described and identified only by its shell morphology. On this basis it has more features which are typical of *Peytonoceras* than of *Eumorphoceras* where it has been placed by Horn with certain reservations. Therefore it is placed here in *Peytonoceras*, but with reservation, too, because of the absence of sutural evidence and the fact that *P. ? involutum* has a divided lateral furrow while the genus *Peytonoceras* has only a single one. The latter difference is not regarded as essential for distinguishing the genera, but only the species. In *Eumorphoceras*, for instance, there are both types of furrows present.

*Occurrence.* E<sub>1a</sub> (close to the base of the Namurian).

#### *Eumorphoceras medusa* Yates

Plate 47, fig. 1

1961 *Eumorphoceras medusa* Yates, p. 54, pl. 6, figs. 1, 2.

*Material.* Three specimens (nos. 573:41 to 43).

*Diagnosis.* A *Eumorphoceras* with a relatively small umbilicus. The sculpture consists mainly of regular, sickle-shaped constrictions.

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#### EXPLANATION OF PLATE 47

- Fig. 1. *Eumorphoceras medusa* Yates. E<sub>1a</sub>. No. 573:41.  
 Fig. 2. *Eumorphoceras medusa*, var. *sinuosum* Yates. E<sub>1a</sub>. No. 573:44.  
 Fig. 3. *Eumorphoceras* (*Edmooceras*) *pseudocoronula* Bisat. E<sub>1a</sub>. No. 573:32.  
 Fig. 4. *Cravenoceras leion* Bisat. E<sub>1a</sub>. No. 573:24.  
 Figs. 5, 6. *Goniatites schaelkensis* (Brüning). Go<sub>2</sub>. 5. No. 573:1. 6. No. 573:2.
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*Description.* When Yates (1961) described *E. medusa* for the first time, she mentioned the close relationship between this species and *E. pseudocoronula*. This relationship is indicated by the regular constrictions and the more reduced ventral part of the lateral furrow. The main differences are as follows. The umbilicus of *E. medusa* is smaller. The ratio diameter to width of the umbilicus of the specimen 573:41 amounts to about 5:1, against 3:1 in *E. pseudocoronula* of equal size. The umbilical edge is raised, but not beaded. There are no intermediate ribs between the constrictions in *E. medusa* which are typical of *E. pseudocoronula*.

As mentioned above, the constrictions are very regular; in specimen 573:43 there are six per half whorl. After leaving the umbilicus in a forward direction they bend back in the middle of the flank, then bend forward again and form a high lingua. The depth of the ventral sinus cannot be measured exactly: it seems, however, to be smaller.

In the region of the lingua there are two furrows, divided by a broad and shallow ridge. The ventro-lateral groove is much fainter and often scarcely visible.

*Occurrence.* E<sub>1a</sub>.

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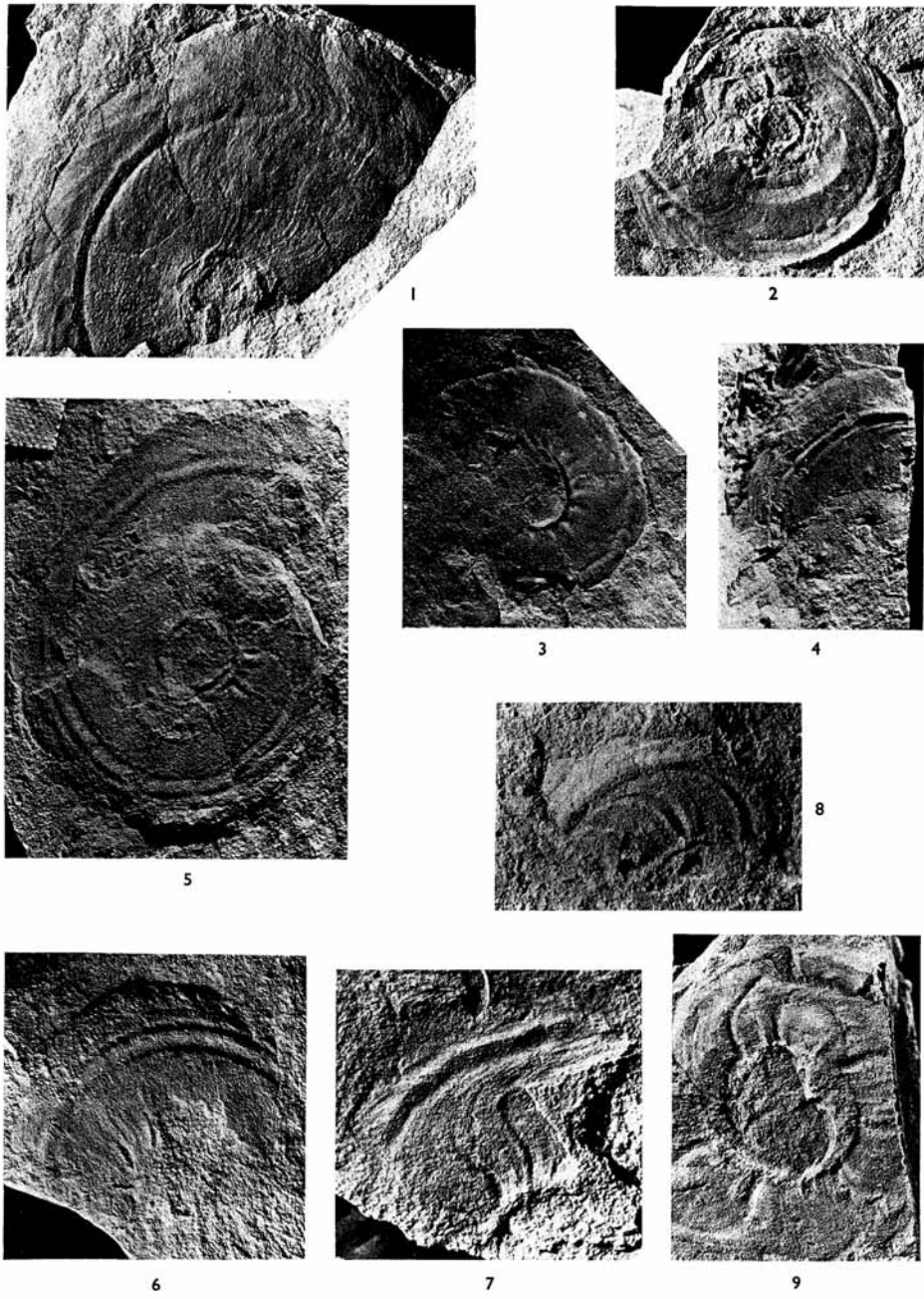
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FIGGE, Carboniferous goniatites



1



2



3



4



5



6

FIGGE, Carboniferous goniatites

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