

SVERIGES GEOLOGISKA UNDERSÖKNING

SER. C.

Avhandlingar och uppsatser.

N:o 527.

ÅRSBOK 46 (1952) N:o 3.

DE GEOLOGISKA RESULTATEN  
FRÅN BORRNINGARNA  
VID HÖLLVIKEN

DEL V:

THE MACRO-FOSSILS OF THE UPPER CRETACEOUS

BY

HILMAR ØDUM

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WITH 4 PLATES

*Pris 3:50*

STOCKHOLM 1953

KUNGL. BOKTRYCKERIET. P. A. NORSTEDT & SÖNER

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## Preface.

This paper is a supplement to Dr. F. Brotzens outstanding paper of 1945 (6). I really mean outstanding, even if I have made some critical remarks, for which I hope he will forgive me.

The two deep wells at Höllviken were drilled by Sveriges geologiska undersökning (Geological Survey of Sweden) during the years 1941—44, and in the last months of 1943 I was entrusted partly with the work at the site of Höllviken II, partly with the examination of all Upper Cretaceous macrofossils from the two drillings. This last part of the work was carried out at the Geological Institute of the University of Lund.

It is a fond obligation for me to express my gratitude to Professor Per Geijer, Director of Sveriges geologiska undersökning; Professor Assar Hadding, chief of Geological Institute of the University of Lund; Dr. F. Brotzen and Mrs. P. Brotzen, Dr. Erik Mohrén, Dr. Seth Stenström and Mrs. Ingrid Stenström and — last, but not least — The Swedish Diamond Rock Drilling Company. I shall never forget the generosity which these — and many other Swedish friends — bestowed on a Danish colleague during the war.

The translation has been undertaken by Mr. P. Baadsgaard, B. A.

Geological Survey of Denmark.

April 1951.

*Hilmar Odum.*

## Chapter I. Palaeontology.

In the following text

- I. 513,55 = Höllviken nr. I, 513,55 meter.  
II. 523,00 = » » II, 523,00 »  
etcetera.

### *Lingula cretacea*. LUNDGR.

LUNDGREN (36). BRÜNNICH NIELSEN (42). RAVN (49 c).

Four specimens can with certainty be referred to this species.

I. 292,20: *L. cretacea*.

I. 513,55: »

I. 760,18: »

II. 523,00: »

Distribution. Literature: Senonian; in accordance to Ravn: Cenomanian-Senonian.

Höllviken: L. Campanian — U. Maastrichtian.

### *Rhynchonella plicatilis* SOW.

DAVIDSON (9). LUNDGREN (36). POSSELT (46). BRÜNNICH NIELSEN (42).  
HÄGG (21 b-c). V. D. WEIJDEN (68).<sup>1</sup>

The species bears radial ribs over the whole surface of the shell, but on the oldest part of the shell they may be so weak that they only are discernible if the shell is slightly worn.

I. 577,00: *R. cfr. plicatilis*.

I. 757,92: *R. plicatilis*.

I. 757,98: »

I. 758,42: »

I. 763,50: » (2 specimens)

I. 764,79: »

I. 873,15: »

II. 608,10: » (?)

Distribution: Literature: Turonian — U. Maastrichtian.

Höllviken: Santonian — U. Maastrichtian.

<sup>1</sup> I cannot omit a reference to dr. Pettitt's work on the Rhynchonellidae (45), even if it is impossible for me to take my material up to a new revision on basis of his paper; partly because his paper is unfinished, partly because I have no access to the Swedish material any longer.

*Rhynchonella limbata* SCHLOTH.

DAVIDSON (9). LUNDGREN (36). POSSELT (46). BRÜNNICH NIELSEN (42).

This species differs from *R. plicatilis* in being quite smooth, without ribs; *i. e.* the structure of the shell contains fine striae which become visible when the shell is worn (it is without any doubt to these striae that Posselt alludes in his remark in the description of *R. cordiformis* (46 p. 26)). — I am very much in doubt about the reliability of Posselt's *R. cordiformis* as an independent species; in its main characters it does not differ from *R. limbata*, and there is nothing in the vertical distribution of *R. limbata* in Höllviken which makes it justifiable to distinguish between an older form »*cordiformis*» (in Bornholm) and a younger form »*limbata*» (in the White Chalk). For *R. cordiformis*, see also RAVN (49 c).

I. 315,40: *R. limbata*.

I. 504,55: »

I. 734,41: » (?)

I. 763,55: »

Distribution. Literature: Senonian.

Höllviken: Campanian — U. Maastrichtian.

*Rhynchonella wahlenbergi* LUNDGR.

LUNDGREN (36). HÄGG (21 c). CARLSSON (7).

In opposition to the *Rhynchonellids* of the smooth or finely-striated *plicatilis*-group (*R. plicatilis* — *limbata* — *cordiformis* — *retracta* etc.) stands a group with coarse and sharp ribs all over the shell; it includes *R. ala* — *wahlenbergi* — *reedensis* (*mantelliana*) and others. (*vide* 36, Lundgren), and they are distinguished from each other by size, form, number of the ribs p. p., even if the size is a character which must be taken with some reservation if one is not sure of having fully grown specimens for examination.

*Rhynchonella wahlenbergi* is adorned with about 30 distinctly marked, rather coarse and unbifurcated ribs.

I. 624,70: *R. wahlenbergi*.

II. 843,50: *R. wahlenbergi*.

I. 733,16: »

II. 920,10: »

I. 849,78: » (?)

II. 931,30: »

I. 895,10: »

II. 946,90: »

I. 1071,17: *R. cfr. wahlenbergi*.

II. 951,50: »

I. 1091,90: *R. wahlenbergi*

II. 1046,90: »

I. 1095,15: » (?)

II. 1053,55: » (?)

I. 1105,30: » (?)

II. 1094,20: »

Two specimens have more narrow and closely spaced ribs, a character which points towards *R. ala* Bronn, but they are too badly preserved to allow a sure determination (I. 666,30 and II. 1169,00).

Distribution. Literature: »Mammillatus-zone».

Höllviken: Santonian — Campanian.

*Rhynchonella* *cfr.* *reedensis* ETHERIDGE.

POSSELT (46). BRÜNNICH NIELSEN (42). RAVN (49 b).

A number of small *Rhynchonellids* are found, fairly well preserved, but incomplete and partly deformed. They are a little smaller than *R. wahlenbergi*, the ribs a little broader and more flat, and the number of ribs never exceeds 10—12.

These cannot be referred to any of the species described by Lundgren but are more in accordance with the specimen which Posselt depicts under the name of *R. mantelliana*; this specimen is later referred to *R. reedensis* by Ravn.

The specimens from Höllviken are here mentioned as *R. cfr. reedensis*, but it must be borne in mind that the material does not allow any critical revision of the species and its position.

I. 621,50:	<i>R. cfr. reedensis</i> .	I. 834,70:	<i>R. cfr. reedensis</i> .
I. 755,14:	» » (?)	I. 843,00:	» »
I. 764,75:	» » (?)	II. 611,35:	» »
I. 807,85:	» »	II. 893,94:	» »
I. 827,30:	» »		

Distribution. Literature: L. Turonian — U. Senonian.

Höllviken: Santonian — U. Campanian.

*Terebratula* *spp.*

A great number of *Terebratulids* have been procured from the whole series of U. Cretaceous beds. They are, however, almost without exception so fragmental or deformed that every closer determination is excluded, so much more so, as it has in all cases proved impossible to study the hinge (*vide* Rosenkrantz 53 and Sahni 54): thus they can only be included as *Terebratula s. l.*

A few somewhat better preserved specimens (II. 1057,60—II. 1072,80—II. 1078,70) may superficially remind one of *T. minor* NILS., but also these are rather defect.

*Terebratulina gracilis* SCHLOTH.

DAVIDSON (9). LUNDGREN (36). POSSELT (46). BRÜNNICH NIELSEN (42).

This species occurs throughout the whole Maastrichtian of Höllviken as rather small but characteristic individuals.

I. 295,77:	<i>T. gracilis</i> .	I. 383,64:	<i>T. gracilis</i> .
I. 321,60:	»	I. 405,20:	»
I. 331,43:	»	I. 541,85:	» (?)
I. 332,90:	»		

Distribution: Literature: »Skivekridt» (White Chalk), i. e. »Mucronatazone».

Höllviken: L. — U. Maastrichtian.

(The absence of this species in Höllviken II may be due to overlooking, or more likely, to the lack of cores.)

*Terebratulina striata* WHLBG.

LUNDGREN (36). POSSELT (46). BRÜNNICH NIELSEN (42). HÄGG (2I a-c).  
RAVN (49-50).

Occurs throughout the greater part of the U. Cretaceous, predominantly in the form *striatula* Mant., sometimes in the form *chrysalis* SCHLOTH.

I. 286,50: <i>T. striata</i> .	I. 573,60: <i>T. striata</i> .
I. 335,50: » (?)	I. 714,40: »
I. 345,78: »	I. 1087,68: »
I. 411 30: »	II. 603,60: »
I. 457,12: »	II. 629,80: »
I. 557,00: » <i>f. chrysalis</i> .	II. 870,70: » (?)
I. 559,60: <i>T. striata</i> .	II. 962,00: »

Distribution. Literature: Neokomian (?) — Danian.  
Höllviken: Santonian — Danian.

*Terebratulina gisi* HAG.

POSSELT (46). BRÜNNICH NIELSEN (42). HÄGG (2I e).

*T. gisi* is mostly somewhat smaller (shorter) than *T. striata* and has furthermore, in contradiction to this last species, unbifurcated ribs. It may be difficult to determine young individuals with certainty, but on full-grown specimens the character of the ribs cannot be mistaken. — The length of the Höllviken-specimens is given below.

I. 415,10: <i>T. gisi</i> .	4,2 mm.
I. 422,80: »	4,0 »
I. 529,40: » (?)	3,6 »
I. 542,30: »	3,0 »
I. 554,30: »	5,2 »
II. 601,35: »	6,4 »

Distribution. Literature: »Skrivekridt», *i. e.* »Mucronata-zone».  
Höllviken: Campanian — Maastrichtian.

*Terebratulina locellus* ROEM.

BRÜNNICH NIELSEN (42).

More oblong than *T. gisii* but otherwise with the same general characters.

I. 405,20: *T. cfr. locellus*.

Distribution. Literature: »Skrivekridt», *i. e.* »Mucronata-zone».  
Höllviken: Ml. Maastrichtian.

*Terebratella scanica* LUNDGR.

LUNDGREN (36).

A somewhat defect specimen probably belongs to this species, described by Lundgren; the rostrum is slightly incurved, the foramen rather large.

A definite determination is, however, not possible, and furthermore Lundgren's original material is so badly preserved (*e. g.* the rostrum is wanting on the type-specimen) that the whole status of this species need a revision on basis of better material.

The species can be distinguished from *T. humboldti* (*vide* BRÜNNICH NILESEN 42) alone by its size.

*Terebratella scanica* has later been mentioned by Carlsson (7) who on pl. IV fig. 9 depicts a fragment, which according to the text p. 21 is identical with Lundgren's type-specimen (36, pl. III fig. 13 b). Nevertheless this cannot be the case; the two depicted shell-fragments have no likeness to each other. In the explanation of the plates does Lundgren give the information that his depicted specimen is derived from Söndraby (without doubt = Oppmanna in the text p. 63) whereas the specimen depicted by Carlsson is labelled »Karstad (nära Råbelöf)».<sup>1</sup>

I. 537,75: *T. cfr. scanica*.

Distribution. Literature: Mammillatus-zone.

Höllviken: L. Maastrichtian.

#### *Magas pumilus* Sow.

DAVIDSON (9). LUNDGREN (36). POSSELT (46). BRÜNNICH NIELSEN (42).

Several well preserved specimens of this species occur in the Höllviken material. They exhibit some variation in the degree of curvature of the rostrum, but there is no reason to pay much attention to this fact, which is well-known from other localities (*e. g.* the Senonian in Denmark); it is partly due to the age of the individual.

I. 324,41—325,30: *M. pumilus*.

I. 326,65: » 2 specimens.

I. 328,56: »

I. 334,15: »

I. 385,82: »

I. 555,45—555,55: »

I. 833,60: »

II. 520,70: » (?).

Distribution. Literature: »Skivekridt» (White Chalk), *i. e.* »Mucronata-zone».

Höllviken: Predominantly in Maastrichtian, but it seems also (if the determination is reliable) to occur already at about the transition Santonian — Campanian. Its absence (?) in Höllviken II may be due to the scarce coring.

<sup>1</sup> I am obliged to dr. J. G. Carlsson for his kindness in giving me the opportunity to examine his specimens.

*Magas pentagonalis* LUNDGR.

LUNDGREN (36).

The species is larger than *M. pumilus*, the rostrum shorter and less incurved, the form is pentagonal, and a sinus is present.

One specimen from Höllviken agrees closely with these characteristics with the exception that the sinus is not developed; but as the individual is rather young one cannot pay much importance to this. — Nevertheless, the determination must be accepted with some reservation.

I. 572,10: *M. cfr. pentagonalis*.

Distribution. Literature: »Mammillatus-zone».

Höllviken: L. Maastrichtian.

*Inoceramus patootensis* DE LORIOI.

SCHLÜTER (57, *I. lobatus*). MÜLLER (40, *I. lobatus*). WOODS (74 and 75 b, *I. lobatus*). RAVN (48). HEINZ (15). HÄGG (21 a—c). DACQUÉ (8). RIEDEL (51). LUNDEGREN (31). KUKUK u. WOLANSKY (27 a).

A group of *Inocerami* which are characterized by rather high and flat, inequilateral shells, with marked — especially posterior — ears; the posterior ear is separated from the shell by a rather distinct keel and a furrow (corresponding with a sinus on the postero-ventral margin); this last mentioned character is easily discernible even on fragments. The shell is ornamented with close-set concentric ridges, at intervals growing into stronger folds.

I. 911,90: *I. patootensis* (*aff. cancellatus*; a little fragment with traces of radial ribs).

I. 916,45: *I. patootensis*

I. 917,00: *I. cfr. patootensis*

I. 936,85: » (part of a small mould; without radial ribs).

I. 942,10: *I. patootensis*.

II. 859,25: » (? might possibly be referred to *I. steenstrupi*).

II. 866,35: »

II. 878,00: »

II. 885,65: »

II. 888,20: » (fragment).

II. 900,50: » (*aff. cancellatus*). Plate II, fig. 3.

II. 904,60: »

II. 906,10: » (*aff. cancellatus*). Plate IV, fig. 5.

II. 906,60: »

II. 910,85: » Plate II, fig. 1.

Distribution. Literature: Woods (74) »from the zones of *Marsupites testudinarius* and *Actinocamax quadratus*». — Riedel (51) »in den oberen Granulaten- und Quadratensenon». — Heinz (15) »*Marsupites testudinarius*-zone». — Kukuk u. Wolansky (27 a) »*Patootensis*-Schichten», *i. e.* Ml. part of L. Senonian, partly

together with *Actinocamax quadratus*. — Lundegren (31)  
 »Die Art hat also in Schonen grössere vertikale Verbreitung  
 als in Deutschland, wo sie ausschliesslich in der oberen Granu-  
 latenkreide angetroffen worden ist». — Heine (13) »Unter-  
 senon». — Stolley (63). »Ober. Granulatenkreide».  
 Höllviken: Upper Santonian.

*Inoceramus patootensis* DE LORIO var. *cancellatus* GOLDF.

HEINZ (15). HÄGG (21 a and 21 b). LUNDEGREN (31). BROTZEN (5—6).

Several specimens of *Inoceramus* reminds of *I. patootensis*, but may be distinguished from this species by their greater size and more coarse concentric ornamentation; furthermore, they are bearing radial ribs. — As to this last character there seems often to be a quite even transition between the two forms, which has made me refer some specimens to *I. patootensis* with the addition »*aff. cancellatus*».

- I. 918,70: *I. cfr. patootensis var. cancellatus*.  
 I. 940,10: *I. cfr. » » »* (fragment).  
 I. 1011,00: *I. patootensis var. cancellatus*. Plate I, fig. 1.  
 II. 899,75: *I. cfr. » » »* (fragment).  
 II. 901,25: *I. patootensis var. cancellatus*.  
 II. 903,60: *I. cfr. » » »* (fragment).  
 II. 905,25: *I. patootensis var. cancellatus*. Plate IV, fig. 4.  
 II. 958,80: *I. cfr. » » »*

Distribution. Literature: Heine (13) »Untersenenon». — Hägg (21 a) »Marsupites testudinarius und Binodosus-zone». — Heinz (15) »Marsupites testudinarius-zone», *i. e.* Upper part of Granulatus-Senonian.

Höllviken: Upper Santonian.

*Inoceramus steenstrupi* DE LORIO.

WOODS (*I. tuberculatus*, 74 and 75 b). RAVN (48). HEINZ (15). HEINE (13).  
 HÄGG (21 a). DACQUÉ (8). RIEDEL (51).

Larger than the two species dealt with above. Ornamented with radial furrows which break the concentric ribs into tubercles.

- II. 857,20: *I. steenstrupi*. Plate IV, fig. 9.  
 II. 871,60: *I. cfr. steenstrupi*.  
 II. 874,30: *I. steenstrupi* (an incomplete but determinable specimen).  
 II. 878,50: *I. cfr. steenstrupi* (a badly preserved specimen).

Distribution. Literature: Heine (13) »Untersenenon». — Woods (74) »Zone o *Actinocamax quadratus*» — Hägg (21 a) »Pinniformis- och Quadratus-Zone». — Heinz (15) »Pinniformis-Zone», *i. e.* a part of L. Granulatus-Senonian. — Stolley (63) »Unterer Horizont d. Unterer Granulatenkreide».

Höllviken: Upper Santonian.

*Inoceramus lingua* GOLDF.

SCHLÜTER (57). WOODS (75 b). HEINZ (15). LUNDEGREN (31). HÄGG (21 b).  
DACQUÉ (8).

Resembles the foregoing species (mostly *I. patootensis*) but has no keel and furrow from umbo to the postero-ventral margin.

II. 859.25: *I. lingua*. Plate IV, fig. 10.

II. 901.00: *I. cfr. lingua* (incomplete specimen).

II. 974.00: » » » »

Distribution. Literature: Stolley (63) »Ober. Granulatenkreide«. — Woods (74) »Zone of Marsupites testudinarius, Actinocamax quadratus and Belemnitella mucronata«. — Riedel (52) »Ob. Granulaten- und Unt. Quadratenenon«. — Riedel (51) »Ober. Untersenon«. — Heinz (15) »Marsupites testud.-Zone«, *i. e.* Upper part of the Granulatus-zone. — Hägg (21 b) »in Sweden the Granulatus-zone»; Hägg reviews the occurrence of the species in several other countries.

Höllviken: Upper Santonian.

*Inoceramus subcardissoides* SCHLÜTER.

SCHLÜTER (57). HEINZ (15—16 a). RAVN (50).

Fragment of a big shell, with heavy concentric folds and more narrow but distinct radial ribs. No radial depression is seen, but it can have been present without being preserved.

II. 1105.60: *I. subcardissoides* (?).

Distribution. Literature. Woods (75) »Upper Chalk«. — Heinz (15) »Inoceramus involutus-zone«, *i. e.* Upper part of Lower Emscherian.

Höllviken. Emscherian.

*Inoceramus digitatus* SOW.

WOODS (75 b). HEINZ (14—15—16 a). HEINE (13).

A fragment of a very large shell of which the form cannot be more precisely determined; irregularly folded, with finger-broad rounded radial ribs, ornamented with lines of growth. — It cannot be referred to any other form than *I. digitatus* Sow. (not to be identified with the form which Schlüter calls *digitatus*, and which now must be referred to *I. undulato-plicatus* ROEM).

II. 1102.70: *I. digitatus* Sow. Plate III, fig. 1.

Distribution. Literature: Woods (74) »Upper Chalk«. — Heinz (15) »Inoceramus involutus Zone, *i. e.* Upper part of Lower Emscherian. — Heine (13) »Involutus-Zone — Unt. undulato-plicatus-Zone«.

Höllviken: Emscherian.

*Inoceramus pinniformis* WILLET.

WOODS (75 b). HEINZ (15). HEINE (13). RIEDEL (51). LUNDEGREN (32). HÄGG (21 c).

From Höllviken has been collected a series of fragments of an *Inoceramus*, fragments because the shell has been so large that coring has only left us excisions of the shell; it is impossible to get a correct impression of the shape. The shell is rather flat and ornamented in a very characteristic way: broad — up to finger-broad — rounded radial ribs with broad interspaces which are crossed by broad concentric ribs, forming flat tubercules on the radial ribs.

All of this agrees with the description and depiction of *I. pinniformis* WILLET given by Woods and Heine (with the exception that the ornamentation seems to be less coarse on Heine's specimen fig. 65).

- I. 1004,10: *I. pinniformis*. Plate IV, fig. 7.  
 II. 963,85: » Plate IV, fig. 1.  
 II. 964,00: »  
 II. 968,70: » (?).  
 II. 974,00: » (?).

Distribution. Literature: Woods (74) »Upper chalk». — Heine (13) »Unter-  
 senon». — Riedel (51) »Untersenenon». — Heinz (14—15) »Ino-  
 ceramus pinniformis-Niveau», *i. e.* Lower Granulatus-Seno-  
 nian. — Kukuk and Wolansky (27 a) »Unterste Senon», *i. e.*  
 Granulatus-zone. — Stolley (63) »Ober. Horizont d. Unter-  
 Granulatenkreide».

Höllviken: (Middle) Santonian.

*Inoceramus cordiformis* SOW.

WOODS (75 b). HEINE (13). HEINZ (14—15). RAVN (49 c). RIEDEL (51).

Fragments of two shells of the same individual, one rather ventricose, one more flat, but, in spite of being compressed, bearing witness of some ventricosity. The sculpture consists of irregular concentric folds (especially on the more ventricose shell) together with close-set lines of growth. Extremely weak traces of radial ribs are seen on the front side of the concentric folds.

- II. 1103,50: *I. cordiformis* (?). Plate I, fig. 2—3.

Distribution. Literature: Woods (74) »Zone of Micraster cor-testudinarium,  
 Micraster cor-anguinum, and in the Unitacrinus band of the  
 zone of Marsupites testudinarium» — Heine (13) »Unterstes  
 Untersenenon». — Heinz (14—15) »Inoceramus cordiformis-  
 Schichten, Ober-Emscher». — Riedel (51) »Ober-Emscher».  
 Ravn (49 c) Lower — Middle Senonian.

Höllviken: Emscherian.

*Inoceramus balticus* BÖHM.

BÖHM (58). WOODS (75 b). HEINZ (15 and 16 a). WOLANSKY (71). V. D. WEIJ-  
DEN (68).

- II. 778,14: *I. balticus*.  
 II. 778,21: »  
 II. 779,80: » Plate IV, fig. 2.  
 II. 779,90: » (?).  
 II. 787,20: » Plate II, fig. 5.  
 II. 930,10: *I. cfr. balticus*.  
 II. 933,35: *I. balticus*. Plate IV, fig. 6.

Distribution. Literature: Woods (74) »from the zone of *Marsupites testu-*  
*dinarius* to the zone of *Belemnitella mucronata*. — Heine  
(13) »Untersenon». — Kukuk u. Wolansky (27 a) »Ober-  
Untersenon». — Wolansky (71) »Quadratensenon». — Heinz  
(15) »Quadratensenon». — v. D. Weijden (68) »Hervensche  
Kreide Zone B».

Höllviken: Upper Santonian — Lower Campanian.

*Inoceramus tegulatus* HAG.

ÖDUM (76). WOLANSKY (71). HEINZ (16 b).

Many fragments of a small, very thin-shelled *Inoceramus* are derived from  
the Upper and Middle part of the Maastrichtian, to a depth of abt. 500 m.  
Their habitus reminds of *I. tegulatus*, wellknown from the »White Chalk» of  
Denmark and N. Germany, even if it must be admitted that none of the —  
badly preserved — fragments displays the characteristic radial sculpture. So  
it is only with some doubt that they are referred to this species.

Among the many specimens the following can be listed:

- I. 327,69: *I. cfr. tegulatus*.  
 I. 336,00: » »  
 I. 379,35: » »  
 II 482,70: » »

Distribution. Literature: Ödum (74) »*Belemnitella mucronata* zone of Den-  
mark». — Wolansky (71) »Mukronatenkreide von Rügen».

Höllviken: Middle — Upper Maastrichtian.

*Inoceramus cycloides* WEGNER.

WEGNER (67). HEINE (13). RIEDEL (51).

The species was described by Wegner in 1905, but in 1910 it was divided  
by Böhm in *I. cycloides* WEGNER and *I. Wegneri* BÖHM. In 1929 Heine took  
the problem up to revision and arrived in a convincing way at the conclusion  
that the two forms are connected by such an even transition that they cannot  
be distinguished from each other.

Also Heinz (14—15) unites the two forms but under the name of *I. Wegneri* J. BÖHM. — The material from Höllviken does not allow a critical review of Heinz' and Riedel's varieties; it must, however, be noted, that the Höllviken-specimens belong to the more oblong-inequilateral form, not the circular one.

I. 1 091, 50: *I. cfr. cycloides*.

II. 912, 70: *I. cycloides*.

II. 930, 60: » (?)

II. 962, 70: *I. cfr. cycloides*.

II. 1 044, 80: *I. cycloides*. Plate II, fig. 6.

Distribution. Literature: Heinz (15) »Inoc. cordiformis Zone — Actinocamax westfalicus-granulatus Zone», *i. e.* Upper Emscherian — Lower Senonian. — Heine (13) as Heinz. — Riedel (51) »Inoc. cordiformis Zone — Quadratensenon». — Riedel (52) »Ober. Emscher — Granulatensenon — unt. Quadratensenon».

Höllviken: Santonian (Lower Santonian ?).

*Inoceramus koeneni* MÜLL.

MÜLLER (39). HEINZ (15—16 a). HEINE (13).

A few specimens from Höllviken belong to a group of *Inocerami*, characterized by being very inequivalve, involute, ornamented with strongly developed concentric ribs or folds, although the two valves differ a great deal also in sculpture. Woods and Heine do not agree in their conception of the relation between them: *I. involutus* SOW. — *I. koeneni* MÜLL. — *I. undabundus* MEEK.

The Höllviken-material is so poor that an absolutely safe determination is difficult (and, of course, it is quite impossible to make a critical review of the relation between the species named), but the fragments of two right valves display so close resemblance to Heinz' *I. koeneni* that I have had no doubt in referring them to this species (*vide* 16 a, Pl. III, fig. 2). Woods *I. involutus* (75 b, fig. 94) is very close to this form.

II. 1 109, 30: *I. koeneni*.

II. 1 110, 35: » Plate II, fig. 4.

Distribution. Literature: Heinz (15) »*Inoceramus koeneni* Zone», *i. e.* Lower Emscherian. — Heine (13) »*Inoceramus involutus* Zone», *i. e.* Lower Emscherian.

Höllviken: Emscherian.

*Avicula pectinoides* REUSS.

LUNDGREN (37). HENNIG (17). RAVN (47).

Fragments of two left valves. The one specimen is completely similar to specimens from the White Chalk of Denmark; the youngest part of the shell bears very faint traces of radially arranged scales.

I. 316,90: *A. pectinoides*.

I. 321,60: » (?)

Distribution. Literature: »Mammilatus» and »Mucronata-Senonian».  
Höllviken: Middle Maastrichtian.

*Lima (Plagiostoma) hoperi* MANT.

HENNIG (18). RAVN (47, 49 b—c). WOODS (75 b). HÄGG (21 a—b). WOLANSKY (71).

This easily recognizable species is frequently found at between 600 and 700 m, always as rather small specimens of the weakly striated type (with sculpture on the oldest part of the valves and towards the sides). From 847,90 m furthermore a fragment of a specimen of the completely smooth type, about 40 mm high; even if the oldest parts of the valve are lost, the determination must be considered as quite safe.

I. 638,65: *L. hoperi*.

II. 622,55: *L. hoperi*.

I. 658,68: »

II. 629,70: »

I. 622,07: »

II. 648,20: »

I. 665,45: »

II. 648,30: »

I. 684,25: »

II. 847,90: »

I. 691,25: »

Distribution. Literature: Woods (75 b) »Zone of Terebratulina lata — Z. of *Ostrea lunata*». — Ravn (49 b—c) Middle Turonian — Upper Senonian. — Hägg (21 a) »Cenoman — Constrictus-zone». — Wolansky (71) »Cenoman — Mukronatensenon».  
Höllviken: Upper Santonian — Campanian.

*Lima (Limea) granulata* NILS.

HENNIG (18). RAVN (47, 49 c). HÄGG (21 a—c). WOLANSKY (71).

A few, not very well preserved specimens.

I. 728,17: *L. granulata*.

II. 520,90: *L. granulata*.

II. 604,50: » (?)

Distribution. Literature: Ravn (49 c) Lower — Upper Senonian. — Hägg (21 a) »Turon — Constrictus-Zone». — Wolansky (71) »Turon — Mukronatensenon».

Höllviken: Campanian — Lower Maastrichtian.

*Pecten (Syncyclonema) nilssoni* GOLDF.

HENNIG (18). RAVN (47, 49 b). HÄGG (21 a—c). WOLANSKY (71).

When reading the palaeontological literature one cannot avoid getting the impression that a good deal of confusion exists about the systematics of this group of smooth Pectines. Already in 1918 Ravn expressed the wish that somebody would undertake a critical revision of the problem, and in 1932 Wolansky tried to establish such a revision. The results arrived at seem to be rather well

founded, even if her material was limited; at least the material from Höllviken — covering much of the Upper Cretaceous — gives good reason to accept Wolansky's characters and systematics of this group.

I. 330,00: <i>P. nilssoni</i> (?).	II. 543,90: <i>P. nilssoni</i> (?).
I. 330,40: »	II. 584,05: » (?).
I. 335,50: »	II. 634,30: »
I. 348,55: » (?).	II. 641,30: »
I. 652,50: »	II. 648,30: » (?).
I. 652,86: »	

Distribution. Literature: Ravn (49 b—c) Upper Turonian — Upper Senonian.  
— Hägg (2I b) »Turon — Constrictus Zone». — Wolansky (7I) »Turon — Mukronatensenon».  
Höllviken: Upper Campanian — Maastrichtian.

*Pecten (Syncyclonema) laevis* NILS.

HENNIG (18). RAVN (50). HÄGG (2I a—c). WOLANSKY (7I).

- I. 334,30: *P. laevis*.  
I. 778,65: »

Distribution. Literature: Ravn (50) Upper Cenomanian — Upper Senonian. — Hägg (2I a) »Turon — Constrictus Zone». — Wolansky (7I) »Turon — Mukronatensenon». — v. d. Weijden (68) »Hervensche Kreide B—C».  
Höllviken: Campanian — Maastrichtian.

*Pecten (Amussium) inversus* NILS.

HENNIG (18). HÄGG (2I a—c). WOLANSKY (7I).

A badly preserved specimen from I. 403,53.

Distribution. Literature: Hägg (2I a) »Binodosus-Zone — Danium». Wolansky (7I) »Senon — Danien».  
Höllviken: Maastrichtian.

*Pecten (Chlamys) serratus* NILS.

HOLZAPFEL (20). HENNIG (18). HÄGG (2I b—c). RAVN (49 c).

The Höllviken-material comprises two shells: an almost intact right valve and a fragment of a (supposed) left valve. They are in all details in accordance with Hennig's description, with the sole exception that the angle between the sides on one of the specimens is close to 90°. — Hagenow's *P. denticulatus* seems to be closely related to *P. serratus* (vide Wolansky 7I).

- I. 295,77: *P. serratus*.  
I. 668,10: »

Distribution. Literature: Hägg (2I b) »Turon — Constrictus-Zone. In Schweden Mammilaten- u. Mukronatenkreide». — Ravn (49 c) Middle — Upper Senonian.  
Höllviken: Upper Campanian — Maastrichtian.

*Pecten (Aequipecten) puggaardi* RAVN.

RAVN (47, 49 b—c). WOLANSKY (71).

This species was originally described by Ravn under the name of *Pecten fenestratus*, but the name was later, for the sake of priority, altered to *P. puggaardi* (a fact which has escaped the attention of WOLANSKY). It is easily determined by its characteristic fenestrated sculpture.

I. 318,90: *P. puggaardi*.

II. 583,90: *P. puggaardi*.

I. 418,38: » (?)

I. 755,84 » (?)

Distribution. Literature: Ravn (49 b—c) Upper Turonian — Upper Senonian.  
— Wolansky (71) »Turon — Senon».  
Höllviken: Campanian — Maastrichtian.

*Spondylus dutempleanus* D'ORB.

WOODS (75 a). RAVN (47). WOLANSKY (71).

The determination of the Höllviken-specimens is made difficult by the strong adhesion of the exterior side of the valves to the rock. Nevertheless the determination may be taken as rather safe.

I. 510,00: *S. dutempleanus*.

II. 905,00: *S. dutempleanus*.

I. 886,80: » (?)

Distribution: Literature: Ravn (47) Younger Senonian — Danian. — Wolansky (71) »Cenoman — Danién».  
Höllviken: Santonian — Maastrichtian.

*Spondylus latus* Sow.

WOODS (75 a). RAVN (47, 49 b). HÄGG (21 a—b).

One specimen from I. 757,95 is rather finely striated and may possibly be referred to *S. latus*.

Distribution. Literature: Woods (75 a) Zone of *Schloenbachia varians* — Z. of *Ostrea lunata*. — Ravn (49 b) Cenomanian — Upper Senonian.  
— Hägg (21 a) »Cenoman — Constrictus-Zone».  
Höllviken: Lower Campanian.

*Spondylus spinous* Sow.

LUNDGREN (35). WOODS (75 a). RAVN (47, 49 c). HÄGG (21 c). WOLANSKY (71).

A single specimen from I. 387,08.

Distribution. Literature: Ravn (49 c) Turonian — Upper Senonian. — Wolansky (71) »Turon — Mukronatensenon». — Woods (75 a) »Zone of *Rhynchonella cuvieri* — Z. of *Ostrea lunata*».  
Höllviken: Maastrichtian.

*Placunopsis granulosa* ROEM.

RAVN (47). WOLANSKY (71).

One specimen is found of this very characteristic species. Wolansky has — without any doubt quite rightly — arrived at the result that *P. undulata* MÜLLER must be identical with *P. granulosa* ROEMER, a possibility which Ravn indicated already in 1902 (47).

I. 315,00: *P. granulosa*.

Distribution. Literature: Wolansky (71) »Mukronatenkride».  
Höllviken: Middle Maastrichtian.

*Anomia papyracea* D'ORB.

WOODS (75 a).

A left valve of an *Anomia* (? the hinge is not accessible) reminds very much of *A. papyracea* D'ORB. as depicted by Woods (75 a, Pl. V, fig. 13). In England and France *Anomia papyracea* is only found in the Turonian. It has no likeness at all to the Senonian form *A. ewaldi* FRECH (vide Holzapfel, 20). On the other hand can a possible affinity with *A. pseudoradiata* D'ORB. not be absolutely excluded (Wolansky, 71).

I. 675,15: *A. cf. papyracea*.

Distribution. Literature: Woods (75 a) »Zone of *Holaster subglobosus*».  
Höllviken: Upper Campanian.

*Ostrea*.

*Ostreids* are found in fragments throughout the whole Upper Cretaceous at Höllviken, but generally in such a poor state of preservation that it is impossible to determine them. Ostreid shell beds occur in well nr. II at depths of about 900—930 m.

*Ostrea incurva* NILS.

HENNIG (18). WOODS (75 b). RAVN (49 b—c, 50). HÄGG (21 a—c). WOLANSKY (71).

A series of better preserved specimens is obtained from the beds of *Ostreids* mentioned. These are rather varying: more or less curved, with more or less predominant, narrow, concentric folds, now and then with fine radial ribs; these characters taken together give a picture of the typical *O. incurva*, within its limits of variation (vide esp. Woods and Hennig). The majority of them are rather small individuals, only a few cm high; the biggest one is 5 cm high.

I. 794,80: *O. incurva*.II. 908,15: *O. incurva*.

I. 889,95: »

II. 910,10: »

I. 1085,73: »

II. 910,55: »

II. 910,65:	<i>O. incurva</i>
II. 911,05—10:	»
II. 911,50:	»
II. 911,80:	»
II. 918,55:	»
II. 920,00:	»
II. 929,70:	»
II. 931,00:	»
II. 972,35:	»

Distribution. Literature: Woods (75 b) »Zone of Schloenbachia varians — Z. of Belemnitella mucronata». — Ravn (49 b—c) Cenomanian — Upper Senonian. — Hägg (21 a) »Turon — Constrictus-Zone». — Wolansky (71) »Cenoman — Senon». Höllviken: Santonian.

*Ostrea lunata* NILS.

HENNIG (17—18). WOODS (75 b). HÄGG (21 c).

One typical individual from II. 928,75.

Distribution. Literature: Woods (75 b) »Zone of *Ostrea lunata*». — Hennig (17—18) in the Cretaceous of Sweden, only known from the Åhus-sandstone. — Hägg (21 e) »Mammillatus- oder Mucronatuskreide».

Höllviken: Santonian.

*Gryphaea vesicularis* LAM.

HENNIG (17—18). RAVN (47, 49 c). WOODS (75 b). JESSEN og ØDUM (26). RIEDEL (51). WOLANSKY (71). V. D. WEIJDEN (68). HÄGG (21 c).

The question of the interrelations between *G. vesicularis* and *Ostrea hippodarium* NILS. has been discussed by many authors; it has also been the object of my studies, and I have advanced the opinion of the identity of the two species (26); so I can here confine myself to referring to the paper quoted. — The distribution of the species has been reviewed by Ravn in many papers, Hägg (21 e) and many other authors.

Specimens determined with certainty are obtained from

I. 412,75.	II. 648,30.
I. 413,20.	
I. 416,20.	

Distribution. Literature: Woods (75 b) »Zone of Schloenbachia rostrata — Z. of *Ostrea lunata*». — Ravn (49 c) Cenomanian — Danian. Wolansky (71) »Valanginien — Danien». — Hägg (21 c) »Valendis — Paleozän».

Höllviken: Upper Campanian — Maastrichtian (— Danian).

*Dreissensia lanceolata* SOW.

HOLZAPFEL (20). WOODS (75 a). HÄGG (23).

One specimen from Höllviken, pyritized, rather well preserved, shows very good resemblance with the species which Woods describes under the name of *Dreissensia lanceolata* SOW. (75 a, p. 110); Holzapfel describes it under the name of *Septifer tegulatus* MÜLLER (20, p. 218). Under this name Holzapfel unites 3 of Müller's species: *Mytilus tegulatus*, *M. falcatus* and *M. lanceolatus* (NB. not SOWERBY'S *lanceolatus*).

Both Holzapfel and Woods (p. 113, top) are inclined to unite all these forms. If this is right the species occurs from the Neocomian to somewhere in the Senonian («Quadratus-zone»).

Because of the state of preservation the Höllviken specimen cannot be determined with absolute certainty.

I. 1103,00: *D. cfr. lanceolata*.

Distribution. Literature: see above.

Höllviken: Lower Santonian.

*Arca tenuistriata* MÜNST.

HÄGG (21 a—b).

One specimen is with some reservation referred to this species.

I. 316,60: *A. tenuistriata* (?).

Distribution. Literature: Hägg (21 a) »Zone d. *Bostrychoceras polyploum*».

Höllviken: Middle Maastrichtian.

*Astarte (Eriphyle) lenticularis* GOLDF.

HÄGG (21 b). V. D. WEIJDEN (68).

One badly preserved specimen is with reservation referred to this species.

I. 455,49: *A. lenticularis* (?).

Distribution. Literature: Hägg (21 b) »Cenoman — Coesfeldiensis-Zone.

Schweden: Granulaten- und Mammillatenkreide».

Höllviken: Middle Maastrichtian.

*Baculites* sp.

*Baculites* is found throughout the whole Upper Cretaceous (with exception of the Danian), more or less deformed and compressed, as moulds and casts. The shell itself is of course dissolved and is often substituted by a thin film of glauconite.

Traces of sutures are never preserved, and faint traces of growth lines or sculpture can only be seen on 3 specimens, — in all cases quite unsatisfactorily and not allowing any determination.

The largest specimen has a cross section of 5,0 × 2,2 cm. (II. 535,72).

If all doubtful specimens are omitted the *Baculites* at Höllviken are distributed in this way:

I. 313,10.	II. 535,72.
I. 325,00.	II. 546,00.
I. 385,20.	II. 578,70.
I. 392,00.	II. 578,80.
I. 395,59.	II. 581,30.
I. 438,00.	II. 614,30.
I. 464,30.	II. 633,15.
I. 507,46.	II. 633,30.
I. 549,65.	II. 644,25.
I. 554,30.	II. 652,00.
I. 717,26.	II. 669,80.
I. 738,45.	II. 787,80.
I. 751,44.	II. 779,05.
I. 753,15.	II. 819,40.
I. 757,90.	II. 863,60.
I. 758,40.	II. 961,60.
I. 761,40.	II. I 087,15.
I. 763,40.	II. I 089,00.
I. 777,09.	II. I 098,80.
I. 800,40.	
I. 818,55.	
I. 853,00.	
I. 855,10.	

*Desmoceras* sp.

One rather deformed and defect specimen of a *Desmoceras* is ornamented with the characteristic furrows. The whorls have an elliptical cross-section; sutures are visible, and so are traces of the surface sculpture of very fine striae (only visible under lense). Actual ribs, accompanying the furrows, are very faint.

I. 310,60: *Desmoceras* sp.

*Bostrychoceras polyplocum* ROEM.

SCHLÜTER (56). NOWAK (44). BROTZEN (6).

One rather fine specimen, but without visible sutures. It is ornamented with about 20 ribs on each whorl, which makes this specimen very like the one depicted by Nowak; the majority of specimens reported from other localities have an ornamentation of more numerous and finer ribs (*vide* e. g. Schlüter).

I. 804,00: *B. cfr. polyplocum*. Plate I, fig. 8.

Distribution. Literature: Stolley (63) »Ober Senon. Mittlere Mukronatenkreide» (polyplocum-Zone).

Höllviken: Lower Campanian.

*Dechenoceras coesfeldiensis* SCHLÜT.

SCHLÜTER (56). DACQUÉ (8).

One fragment of the youngest whorl shows in its ornamentation of sickle-shaped ribs — varying both in strength and direction — rather close resemblance with the specimen depicted by Schlüter (56, pl. 17, fig. 1). Sutures are not seen. The determination may nevertheless be considered as uncertain.

II. 611,12: *D. coesfeldiensis* (?). Plate III, fig. 2.

Distribution. Literature: Stolley (63) »Ober-Senon. Untere Mukronatenkreide» (coesfeldiensis-Zone). — Kukuk und Wolansky (27 a) »Mukronatensenon».

Höllviken: Upper Campanian.

*Hauericeras pseudo-gardeni* SCHLÜT.

SCHLÜTER (56). MÜLLER u. WOLLEMANN (41). DACQUÉ (8). RIEDEL (51). HÄGG (21 a—b).

One young well preserved individual. It concurs in its whole habitus very well with this species; the sharp limit of the whorls towards the umbilicus is very distinct; the surface sculpture is very faint, but this, too, is in accordance with the description given by Müller u. Wollemann.

II. 1078,80: *H. pseudo-gardeni*. Plate IV, fig. 11.

Distribution. Literature: Stolley (63) »Mittel-Senon. Obere Granulatenkreide» pseudogardeni-Zone). — Riedel (51, p. 626) »Unter-Senon».

Höllviken: Emscherian (or L. Santonian?)

*Puzosia mangedensis* SCHLÜT.

SCHLÜTER (56). DACQUÉ (8). RIEDEL (51). BROTZEN (6).

II. 1081,25: A badly preserved fragment, displaying a couple of the characteristic furrows.

II. 1082,45: A very small fragment, with traces of the characteristic sculpture; may with some reservation be referred to this species.

II. 1086,85: A rather well preserved specimen, with much of the last whorl present; the size of the umbilicus is visible, but the inner whorls are destroyed. — Five or six of the characteristic furrows are seen and behind each a faint rib which forms a faint tubercule on the margin (the same may be seen on the two other fragments). The rest of the surface is smooth; no sutures visible — Plate IV, fig. 8.

Distribution. Literature: »Emscher» (Riedel a. o.)

Höllviken: Emscherian.

*Tragodesmoceras hernense* SCHLÜT.

SCHLÜTER (55). WOLLEMAN (72—73). DIENER (10).

One rather well preserved specimen, comprising  $\frac{1}{3}$  of the last whorl plus traces of the inner ones. Large, open umbilicus; faint, broad ribs and with interspaced coarser ribs (accompanied by a furrow), forming a series of tubercles along the margin.

It must in all probability be referred to Schlüter's original *Ammonites hernensis* (1867) which occurs in the Emscherian, and is not to be mistaken for his later *A. H.* (1872), which Grossouvre has described as *Puzosia (Tragodesmoceras) mülleri* and which belongs to the Turonian.

II. 1 021,00: *T. cf. hernense*. Plate IV, fig. 3.

Distribution. Literature: se above.

Höllviken: Lower Santonian.

*Scaphites*.

A number of more or less well preserved *Scaphites* are found at Höllviken, but it will be remembered that certain groups of this genus exhibit such a great variation that it may be difficult to determine them with certainty, unless the suture is visible (*vide* Nowak 43). None of the specimens from Höllviken have visible sutures, and furthermore most of them are either very young individuals or very fragmental.

*Scaphites (Hoploscaphites) constrictus* SOW.

SCHLÜTER (56). MOBERG (38). GROSSOUVRE (11). RAVN (47). NOWAK (43—44). WOLANSKY (71).

I. 315,60: *S. constrictus* (?).

I. 375,57: » *var. tenuistriatus* KNER. Plate I, fig. 6.

I. 388,20: » » »

I. 389,40: » » *vulgaris* (?).

I. 469,25: » » » . Plate I, fig. 5.

Distribution. Literature: Stolley (63) »Obere Mukronatenkreide«. — Wolansky (71) »Obere Mukronatenkreide«.

Höllviken: Middle Maastrichtian.

*Scaphites (Acanthoscaphites) tridens* KNER.

SCHLÜTER (56). RAVN (47). NOWAK (43—44). WOLANSKY (71). ANDERSEN (1). BROTZEN (6).

One large and rather well preserved specimen bearing three rows of tubercles.

I. 314,50: *Scaphites tridens* KNER. (*f. trispinosus* GEINITZ). Plate I, fig. 4.

Distribution. Literature: Wolansky (71) »Mukronatensenon«.

Höllviken: Middle Maastrichtian.

*Scaphites (Acanthoscaphites) roemeri* D'ORB.

SCHLÜTER (56). MOBERG (38). RAVN (47). WOLANSKY (71). BROTZEN (5 b—6).

Some fragments can without any doubt be referred to this species. One specimen (I. 643,40) is not only ornamented with the fine ribs but displays furthermore a row of faint tubercles along the margin.

- I. 639,25: *S. roemeri*.  
 I. 643,40: »  
 I. 651,40: »  
 I. 655,80: »  
 I. 786,00: » (?)

Distribution. Literature: Wolansky (71) »Mukronatensenon».

Höllviken: (Lower Campanian ?) — Upper Campanian.

*Aptychus* spp.

Several *Aptychi* have been collected from various depths, but no attempt at a more close determination has been made as the stratigraphical value of them is doubtful.

- |            |             |
|------------|-------------|
| I. 546,50. | II. 574,40. |
| I. 649,40. | II. 606,50. |
| I. 661,39. |             |
| I. 797,90. |             |
| I. 845,50. |             |

*Actinocamax*.

The material from Höllviken consists of 7 whole or fragmental specimens; 1 fragment of a length of 1 cm gives no possibilities at all for determination; the other 6 specimens can with more or less certainty be referred to the group:

*Actinocamax westfalicus* SCHL. — *A. westfalicus-granulatus* BL.

SCHLÜTER (56). MOBERG (38.) STOLLEY (60 and 63). RAVN (49 c and 50). HÄGG (21 a—b). WOLANSKY (71). LUNDEGREN (33 and 34). BROTZEN (5 b—6).  
 V. D. WEIJDEN (68).

It will be known that *A. westfalicus* — *granulatus* — *quadratus* form a development series,<sup>1</sup> whose links are connected by even transitions in such a way, that it can often be difficult to determine with certainty to which »species» a single individual must be referred. So much more uncertain must the determination be when the material is restricted to a few and partly fragmental specimens from a drilled well, — without any possibility for considering the amplitude of variation of the single criteria within the given population and within the same horizon.

<sup>1</sup> I prefer this neutral term to Stolleys and Lundegrens term »Mutationsreihe».

Enumerated from below we have the following specimens:

- II. 1 080,40: A 10 mm long fragment of the alveolar part of the guard; no granulation visible. The alveolus has apparently been rather deep, in cross-section  $8,3 \times 7,6$  mm, the form being slightly compressed. The specimen may be referred to the form *A. westfalicus-granulatus*.
- II. 1 058,00: A specimen more than 40 mm long (the end of the guard being lost). The guard is slenderly club-shaped, maximum thickness 7,7 mm, narrowing towards the alveolus which is oval-compressed; lateral furrows are present but no granulation. *Actinocamax westfalicus*. Plate I, fig. 9.
- II. 1 035,50: A complete specimen. Length of the guard 74 mm, with a maximal diameter of 8,4 mm. Alveolus oval-compressed, about 2 mm deep; the ratio alveolus : guard being 1 : 37. The form of the guard is almost cylindrical, very faintly club-shaped. Mucro present. The slice of the alveolus is but slightly discernible. Lateral furrows present; no granulation. The specimen can best be determined as being close to *Actinocamax westfalicus-granulatus*. Plate I, fig. 10.
- I. 1 082,27: An almost complete specimen, only the end of the guard wanting. Length in the present state 57 mm, maximum diameter 10 mm; form almost cylindrical, only slightly club-shaped. Alveolus in cross-section  $9,0 \times 7,5$  mm, 3,3 mm deep; slice very short and faint. Estimated length of the guard about 60 mm gives the ratio alveolus : guard = 1 : 18. Lateral furrows and faint striae and granulation are present. — This specimen has already been determined by Brotzen (5 p. 57) as *Actinocamax westfalicus-granulatus*. Plate I, fig. 11.
- I. 1 051,15: A 37,5 mm long fragment, without alveolus. The greatest, circular diameter being 10 mm; mucro present; lateral furrows and a very faint granulation are present. The form of the guard can not be definitely determined, but as it is the specimen does not show any tendency to club-shape. — Probably *Actinocamax westfalicus-granulatus*.
- I. 688,35: A 43 mm long fragment without alveolus. Maximum circular diameter 9,3 mm. The guard is rather pointed but a real mucro is wanting. No granulation is present, but a very fine irregular striation. — The determination is very uncertain (even the possibility of its reference to *Belemnitella* cannot be excluded).

As to the 2 specimens from II. 1 035,50 and I. 1 082,27, both determined as *A. westfalicus-granulatus*, it must be observed that the ratio alveolus : guard is essentially less than the figures arrived at by Lundegren (33 diagram p. 298, and 34 p. 10).

*Belemnitella mucronata* SCHLOTH.

MOBERG (38), STOLLEY (60). HÄGG (21 a—b). LUNDEGREN (33). V. D. WEIJ-  
DEN (68). JELETZSKY (24—25).

To this species is referred:

- I. 451,75: A little fragment of the alveolar part of the guard.
- I. 599,50: Another alveolar fragment.
- II. 573,50: An incomplete guard, with both ends missing, 50 mm long; maximum diameter 14 mm. Lateral furrows and vascular impressions are distinct.
- II. 798,00: An almost complete guard, 70 mm long and with a maximal diameter of 12 mm. Mucro and a deep alveolus are present, and the same is the case with lateral furrows and vascular impressions even if they are not very strongly developed.

*Belemnitella mucronata* occurs at certain Swedish localities together with *Actinocamax granulatus*: Eriksdal, Kullemölla, Lyckås, and the same is the case in Germany (*vide* Hägg, 21 a p. 67 and Lundegren, 33 p. 286); so it is not surprising to find it with the following distribution in Höllviken: Lower Campanian — Middle Maastrichtian.

*Scalpellum (Arcoscalpellum) fossula* DARW.

WITHERS (69—70).

A single, well preserved scutum is found.

I. 635,00: *S. fossula*.

Distribution. Literature: Withers (70) »Middle — Upper Senonian».  
Höllviken: Upper Campanian.

*Brachylepas fallax* DARW.

WITHERS (69—70).

3 fragments with the same ornamentation are found, and 2 of them can both as regards ornamentation and morphology, be identified with Withers' depictions of scutum and tergum.

I. 461,52: *B. fallax*.

I. 504,31: »

I. 521,50: »

Distribution. Literature: Withers (70): »Turonian — Senonian».  
Höllviken: Lower and Middle Maastrichtian.

## Chapter II. Stratigraphy.

### General Remarks.

During more than a century the geologists of Northern Europe have tried to establish an all-comprising stratigraphy covering the Cretaceous system of this part of the continent. Especially it has been tried to work out an Upper Cretaceous stratigraphy for Sweden — Denmark — Northern Germany, based upon the occurrence of certain guide-fossils, in this case macro-fossils.

The result of these efforts has been that each geologist who has approached the problems of a more detailed stratigraphy of the Cretaceous has solved the problems in his own way. Nobody has been able to reach a generally applicable solution. No comprehensive correlation has been established.

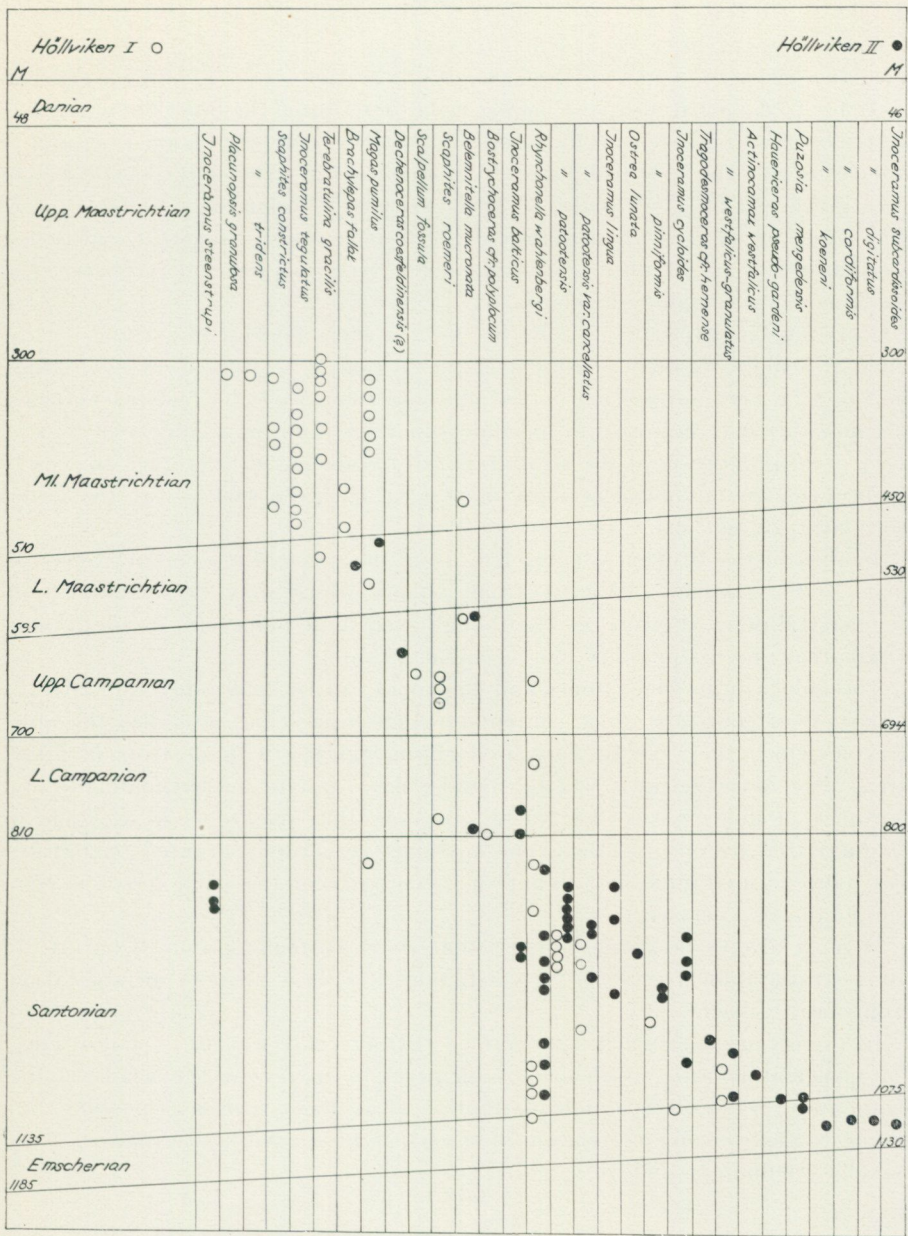
This is partly due to the fact that all the examined localities are situated along the borders of »The North European Syncline» (or basin) and its branches, more or less near to the coast; and the population of animals near to the coast is always influenced by local ecological factors. The time-factor, which is the only essential in regard to stratigraphy, was always veiled by other factors; the occurrence and distribution of »guide-fossils» was never the same. The searched »normal-section» did not exist (*vide* Lowman 27 *b*).

The only way to find a »normal-section» would be to drill through the Upper Cretaceous at a suitable locality, situated in the basin in such a way that it was influenced as little as possible by all local factors, in other words as far from the coast as possible. — The »Grøndals-boring» by Copenhagen (4, 5 *a*) might perhaps have solved many problems, but neither did the technical development of the time (1894—1907) permit drilling to a sufficient depth, nor did it permit the recovery of the necessary guide-fossils.

Two deep wells were drilled during the years 1941—1944 by The Geological Survey of Sweden in the southernmost part of Sweden, and the results — as far as the Upper Cretaceous is concerned — were published 1945 by dr. F. Brotzen (6).

The classic form of stratigraphic geology was based upon macro-fossils, and it presupposed that the geologist was able to get a »broad» view of the whole population of fossils. This is of course impossible in a drilled well and Brotzen was forced to make his choice: he based his stratigraphical work on micro-fossils and especially on foraminifera. The result thus obtained is given in his diagrams (6, p. 60—61 and pl. 3). — As far as the beds of Emscherian — Maastrichtian age are concerned I have been entrusted with the task of reviewing the macro-fossils of these two drillings.<sup>1</sup>

<sup>1</sup> As the material of Danian macro-fossils is rather scarce, but on the other hand is richly supplemented from other drillings, I hope to be able to present a survey of the Danian in another paper.



Two essential principles must be borne in mind when working with stratigraphical problems (cfr. i. a. Hedberg 12, Lowman 27 b and »Stratigraphical Commission», 79, p. 2360—2365):

1) If a geologist works on the basis of one section — or a complex of local sections — he must use *local names* in his description; he must designate the layers by their petrological characters and fossil content, but he must be careful not to ascribe too much importance to these fossils. The guide-fossils which in a given section — or series of local sections — occur in a »reliable» way will sooner or later occur in different layers in another district; it will prove very difficulty to establish a sure system of synchronology on the basis of a local sequence of »guide-fossils».

2) If a geologist wants to give his work a more general importance, if he aims at a more regional treatment of the section or sections he is describing, he must be very careful not to use the local names of the beds or horizons because this may give rise to misunderstandings (and, as a matter of fact, a very great proportion of the stratigraphical discussions in literature are based upon misunderstandings); he must use *neutral names* in such a way that later correlation is not made impossible.

In this dilemma Brotzen is correct in using the names Emscherian — Santonian — Campanian — Maastrichtian (stages which may be subdivided in »Upper», »Middle», »Lower» ect.). Although even these names are »local» in their origin they have acquired a more general meaning.

The only way in which zones and sub-zones can be determined and characterized is of course by their content of guide-fossils, and it is also the only way in which they can be compared chronologically with deposits in other areas. But nevertheless it will be sound politics not to overestimate the importance of guide-fossils. The ideal situation: that one zone or sub-zone is characterized by one species (»zone-fossil») is very rarely granted by nature. We have no guarantee at all that the occurrence of the »zone-fossil» is contemporaneous everywhere.

It must always be borne in mind that every systematization of nature — as in stratigraphical geology — is a fiction; it always includes an aberration from nature itself.

In this situation it will be understood that the only way of, — not solving, but penetrating into unsolvable problems — is to review the whole fauna, examining the occurrence and distribution of as many species as possible and trying to deduce some correlation in the whole puzzle-work of sediments (*vide* Arkell 3, Ödum 77 and 78).

### Höllviken.

Brotzen has tried to do this by examining the distribution of foraminifera in the Upper Cretaceous of Höllviken and to use certain foraminifera as zone-fossils (besides the macro-fossils available when he wrote his paper). There is no doubt that the introduction of foraminifera is the only way to avoid several

complications. — I will return to these subjects later on, but on the other hand it cannot be denied that Brotzen's paper is a »Preliminary Report» and is written in some haste. The importance which is ascribed to certain species as »zone-fossils» in pl. 3 is not in accordance with the distribution of these same species in the diagram pl. 4 and the text; but these corrections may be left to dr. Brotzen himself. — The only principle which I might mention in this connection — with address to many authors — is that the term »main distribution» of a zone-fossil or guide-fossil is a contradiction in itself in so far as the occurrence of a zone-fossil ought to be confined to the zone mentioned. It may, as stated above, be very difficult to find a single species which fulfills this demand, and the zone must then be characterized by a set of fossils (and named after these); each of these fossils composing a set can only be regarded as a »zone-fossil» in connection with all the other ones. — I know that this point of view is in contradiction with f. i. Hedberg's (12, p. 1976) but I cannot agree with him.

Variations in abundance may be due to many factors, but the only essential factor for a guide-fossil or a zone-fossil is the time-factor. The only important question is the existence or non-existence of a species.<sup>1</sup>

I have not had in mind to establish a well-founded stratigraphy of the Upper Cretaceous of Northern Europe; my sole object is to supplement Bortzen's paper with a review of the macro-fossils recovered from the two drilled wells. I need not explain why it is quite accidental which macro-fossils are found or not found in a drilled well. My task is to give the facts, but even this limited task has forced me to consider the principles of stratigraphy, as has been done on the preceding pages.

I have found this so much more urgent as we are living at a time when we are being forced to abandon the classic ways of stratigraphy. All the wells being drilled for water, oil or other products cost vast sums of money, and so we are forced to find stratigraphical methods that can be applied in drilled wells. In other words: we are forced to acknowledge the use of micro-fossils, even if this includes a revision of our classic stratigraphy; and we must use as neutral and general names for the stages as possible.

So far Brotzen has adopted the right methods. The only thing left to me is to supplement his paper with a review of the macro-fossils obtained. This is done in detail in chapter I and, for a selected set of fossils, in the diagram p. 29. In this diagram I have only given the facts procured from these two wells; for a more comprehensive review I must leave it to future authors to collect the necessary information from other localities.

In so far leaving the facts to speak for themselves I have only a few comments to make.

<sup>1</sup> In this connection it can be necessary to warn against an uncritical tendency to compare the »relative abundance» of foraminifera in prequaternary deposits with the relative occurrence of pollen in quaternary deposits. The changes in ecological factors upon which pollen-statistics are founded cannot be paralleled to anything which might permit a similar use of foraminifera, whose ecological demands are not known (cfr. Lowman, 27 b).

Many systems of stratigraphy have during the last century been founded either on certain »zone-fossils» or on the distribution of species belonging to certain genera. I think that it is clear that many of these »systems» are of limited value; they can only be of use within local areas.

This applies especially to the systems based on the occurrence of Belemnites. The various species of Belemnites are of very little real value in regional stratigraphy (a fact which is conspicuous when considering the works of Stolley and Lundegren), and they are absolutely of no practical value when working on the basis of well samples; no reliable conclusions can be drawn from the casual presence or absence of Belemnites in cores or ditch samples.

The same is to some extent the case with *Inocerami*. The occurrence of determinable specimens must be casual in drilled cores; but nevertheless the *Inocerami* from Höllviken seem to be in accordance with these few species in Heinz's Inoceramenprofil (15).

The occurrence of *Inocerami* and a few other »guide-fossils» in Höllviken tend to corroborate Brotzen's stratigraphy, based on the foraminifera. Other acknowledged »guide-fossils» must be submitted to revision on the basis of a »broader» material than that at my disposal.

#### Linguistic Remarks.

A few words must be added on the language of stratigraphy.

All names of the greater units in stratigraphy or many names in palaeontology are based on the latinization of place-names or other names, *e. g.* Cambrium or Carboniferous (nobody would dream of using the word »coal» without latinizing it). The French, English or German names are all parallel to the Latin name, with national endings. In introducing new names special care must therefore be taken to use the correct latinization. To illustrate what I mean I cannot avoid reference to Brotzen's latinization of Danish place-names (but my critical remarks may be addressed to many other authors).

Brotzen introduces the two words »*Möenian*» and »*Stevnsian*». All right, — but firstly the name of the Danish island is Mön, not Möen; and secondly the latin form is (Insula) Meonia. So the correct stratigraphical form is *Meonium* or Meonian. And the Danish district (Peninsula) of Stevns is called in Latin »Promontorium stefnense»; the correct stratigraphical form is consequently *Stefnium* or Stefnian.

But whatever you do, do it consistently. In his diagrams, p. 60—61, Brotzen uses correctly enough the English form »-an». But in pl. 3 he writes Danien (French), Maastrichtien (French), Campan (German), Santon (German) etc. — I know that I am myself liable to criticism on these grounds, — but nevertheless: why not use a linguistically correct name, and use it consistently?

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Abbreviations: G. F. F. = Geologiska Föreningens i Stockholm Förhandlingar. Stockholm.

S. G. U. = Sveriges Geologiska Undersökning. Stockholm.

D. G. U. = Danmarks Geologiske Undersøgelse. København.

M. D. G. F. = Meddelelser fra Dansk Geologisk Forening. København.

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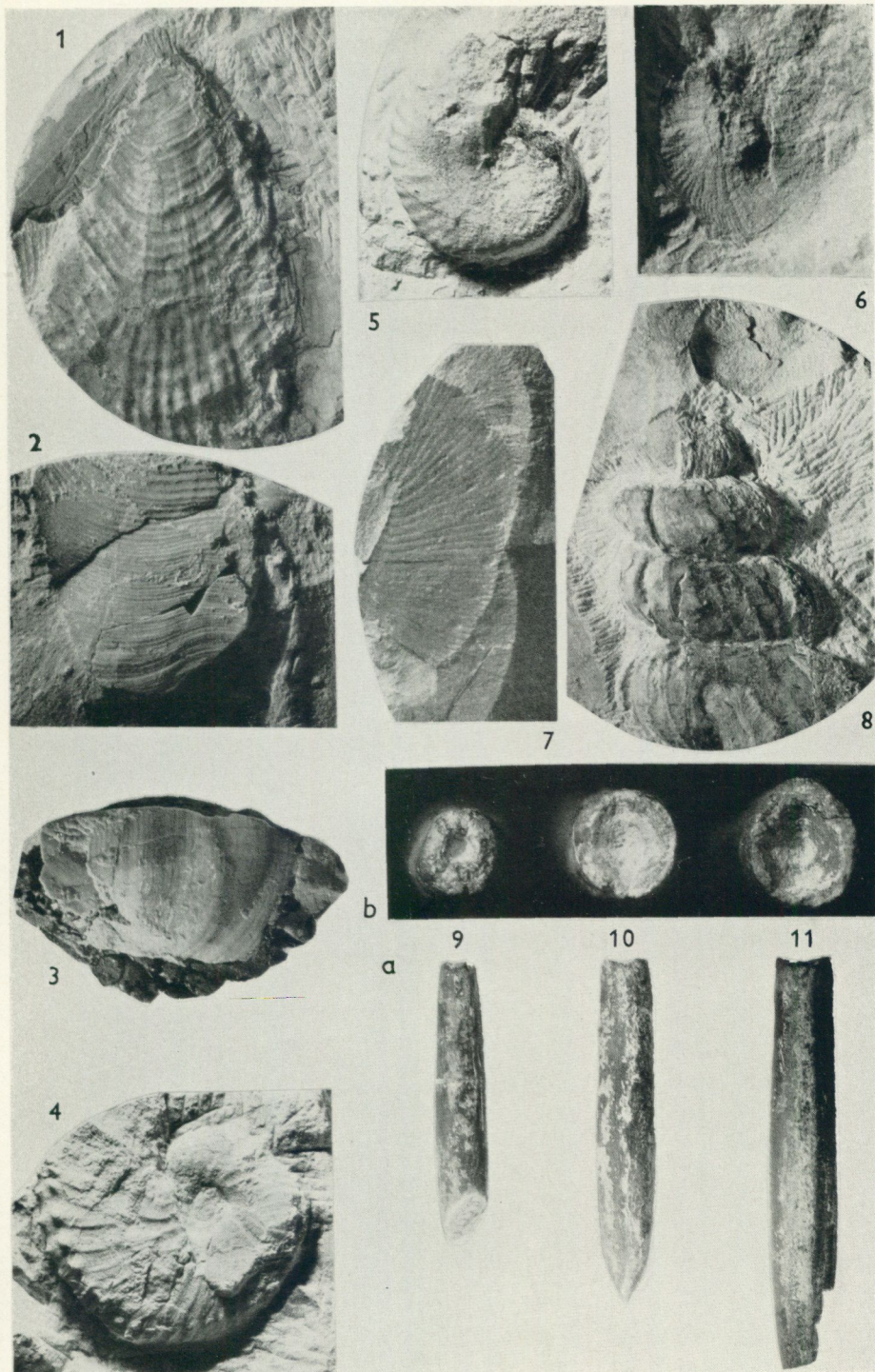
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### Plate I.

- Fig. 1. *Inoceramus patootensis* DE LOR. var. *cancellatus* GOLDF. I. 1011,00. 1 × 1  
» 2. *Inoceramus cordiformis* SOW. (?). II. 1103,50. 1 × 1.  
» 3.       »       »       »       »       » II. 1103,50. 1 × 1.  
» 4. *Scaphites tridens* KNER. I. 314,50. 1 × 1.  
» 5. *Scaphites constrictus* SOW. var. *vulgaris* KNER. I. 469,25. 1 × 1.  
» 6. *Scaphites constrictus* SOW. var. *tenuistriatus* KNER. I. 375,57. 1 × 1.  
» 7. *Scaphites roemeri* D'ORB. I. 643,40. 1 × 1.  
» 8. *Bostrychoceras* cfr. *polyplocum* ROEM. I. 804,00. 1 × 1.  
» 9a. *Actinocamax westfalicus* SCHLÜT. II. 1058,00. 1 × 1.  
» 9b. Alveolus of 9 a. 2 × 1.  
» 10a. *Actinocamax westfalicus-granulatus* BL. II. 1035,50. 1 × 1.  
» 10b. Alveolus of 10 a. 1 × 1.  
» 11a. *Actinocamax westfalicus-granulatus* BL. II. 1082,27. 1 × 1.  
» 11b. Alveolus of 11 a. 2 × 1.

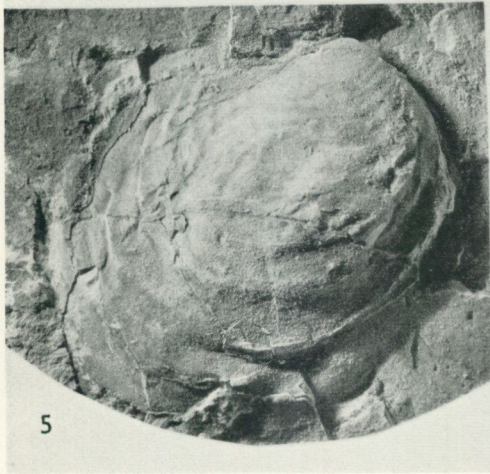
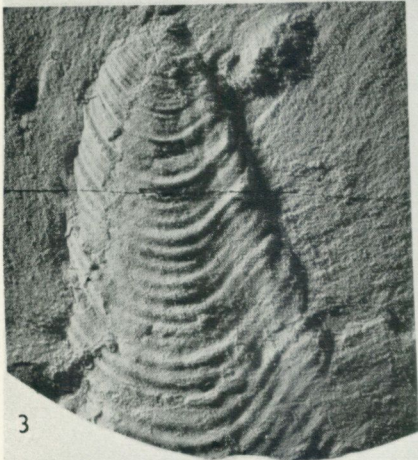
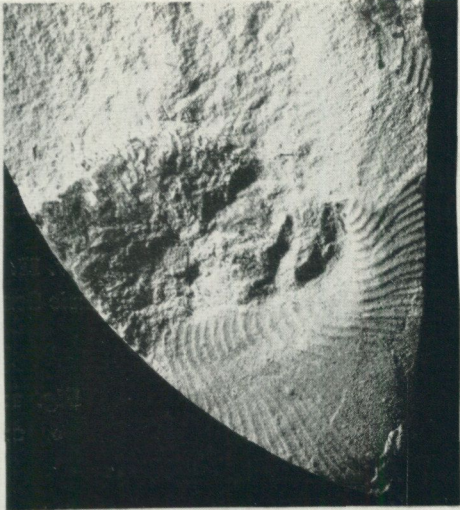
INGRID STENESTRÖM fot.



**Plate II.**

- Fig. 1. *Inoceramus patootensis* DE LOR. II. 910,85. 1 × 1.  
» 2. *Scaphites roemeri* D'ORB. I. 639,25. 1 × 1.  
» 3. *Inoceramus patootensis* aff. *cancellatus* Goldf. II. 900,50. 1 × 1.  
» 4. *Inoceramus koeneni* MÜLL. II. 1110,35. 1 × 1.  
» 5. *Inoceramus balticus* BÖHM. II. 787,20. 1 × 1.  
» 6. *Inoceramus cycloides* WEGN. II. 1044,80. 1 × 1.

INGRID STENESTRÖM fot.



**Plate III.**

Fig. 1. *Inoceramus digitatus* SOW. II. 1102,70. 1 × 1.

» 2. *Dechenoceras coesfeldiensis* SCHLÜT. II. 611,12. 1 × 1.

Fig. 1: F. BROTZEN fot.

» 2: INGRID STENESTRÖM fot.

1



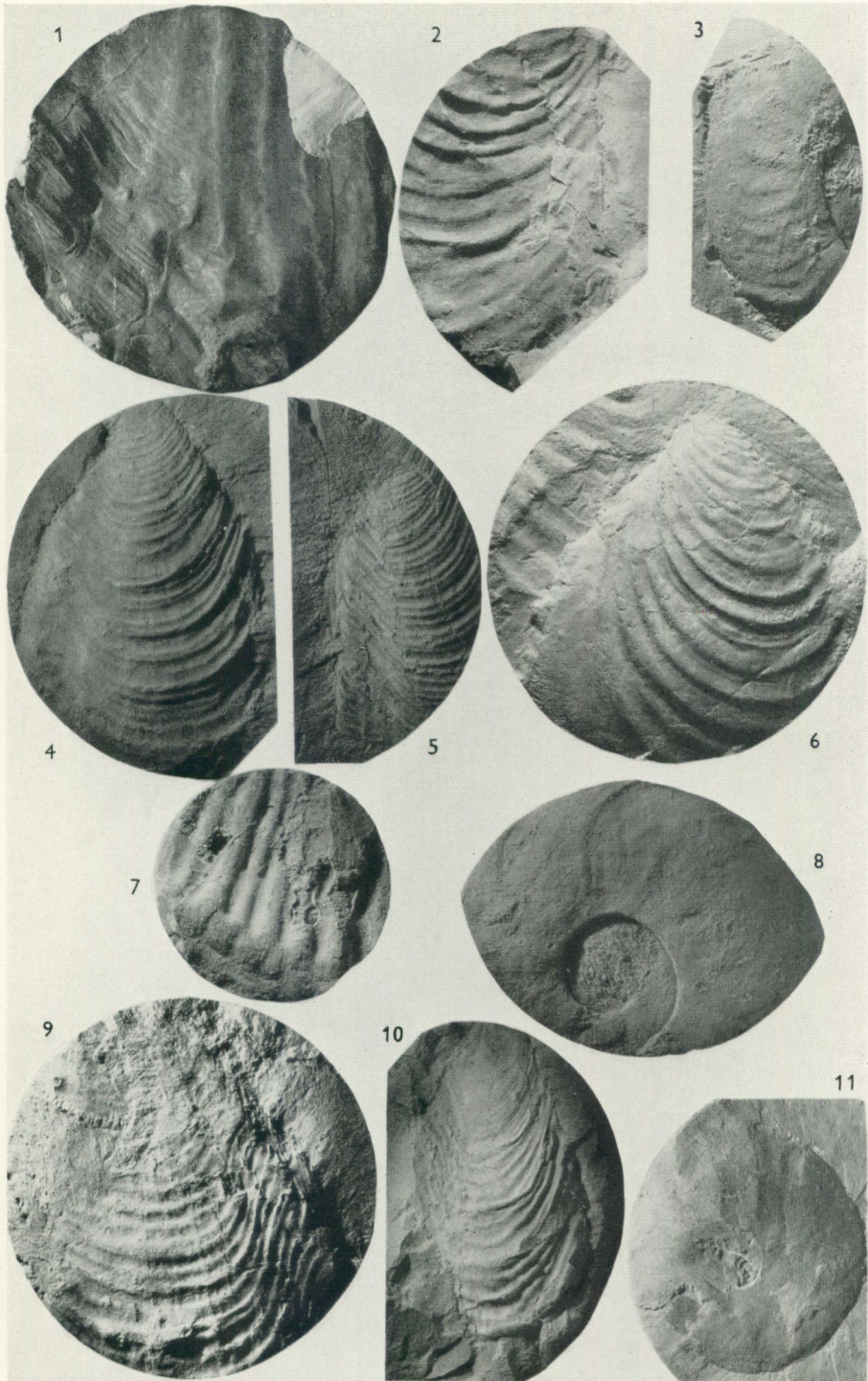
2



Plate IV.

- Fig. 1. *Inoceramus pinniformis* WILLET. II. 963,85. 1 × 2.  
» 2. *Inoceramus balticus* BÖHM. II. 779,86. 1 × 2.  
» 3. *Tragodesmoceras* cf. *hernense* SCHLÜT. II. 1021,00. 1 × 2.  
» 4. *Inoceramus patootensis* var. *cancellatus* GOLDF. II. 905,25. 1 × 2.  
» 5. *Inoceramus patootensis* aff. *cancellatus* GOLDF. II. 906,10. 1 × 2.  
» 6. *Inoceramus balticus* BÖHM. Gypsum mould of the interior of the valve.  
II. 933,35. 1 × 2.  
» 7. *Inoceramus pinniformis* WILLET. I. 1004,10. 1 × 2.  
» 8. *Puzosia mangedensis* SCHLÜT. II. 1086,85. 1 × 2.  
» 9. *Inoceramus steenstrupi* DE LOR. II. 857,20. 1 × 2.  
» 10. *Inoceramus lingua* GOLDF. II. 859,25. 1 × 2.  
» 11. *Hauericeras pseudo-gardeni* SCHLÜT. II. 1078,80. 1 × 2.

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