Danmarks Geologiske Undersøgelse.
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Studies on the Bryozoan Species Coscinopleura elegans and Coscinopleura angusta n. sp. from the Senonian and Danian Deposits of Denmark.

By

Ole Berthelsen.

Med dansk Resumé.

I Kommission hos

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Introduction.

The following is an attempt to employ the Bryozoa in the stratigraphy of the Danish Cretaceous system.

Authors who have previously occupied themselves with the Bryozoa in the Danish chalk have treated them from zoological and palaeontological aspects; in a few papers only are there peripheral remarks of stratigraphical significance.

Below is an account of my studies on the species *Coscinopleura elegans* (VON HAGENOW), comprising variations in the width of the colonies in specimens from various limestone and chalk localities, and also an examination of the marginal vibracula and caenozooecia. I have not gone into the question of the structure and placing of zooecia and ooecia, these cells having been described by several authors, especially BEISSEL (1865), MARSSON (1888), CANU (1913) and CANU & BASSLER (1920).

The material necessary was secured by means of loans from the Zoological Museum, the Mineralogical Museum both of the UNIVERSITY OF COPENHAGEN and the GEOLOGICAL SURVEY OF DENMARK (D. G. U.), as well as by my own collections. I take this opportunity to thank Dr. P. KRAMP of the Zoological Museum, Professor A. ROSENKRANTZ of the Mineralogical Museum and Dr. H. ØDUM of the Geological Survey of Denmark for kindly assisting in procuring the material and permitting me to publish it.

When collecting Bryozoa from Danish chalk and limestone localities in various parts of the country I became aware of a difference in the width of the specimens of *Coscinopleura elegans* from the Senonian and those from the Danian sediments. This observation was supported by LEVINSEN'S description of species in "Undersøgelser over Bryozoerne i den danske Kridtformation" (1925). In that work LEVINSEN states that in addition to the type species a distinction can be made between two varieties, *a* and *b*, of which *var. a* is of

particular interest in this connection. It is described as follows (page 88): The avicularia, which are pierced by fewer pores, are not arranged in any continuous series along each lateral margin, being separated partly by ordinary zooecia, partly by vestigial marginal zooecia. The width of the zoaria is 1½–2 mm.

LEVINSEN found this variety in the following Danian localities: Faxe, Stevns and Karleby Klint, but there is no record of it from a Senonian locality. On the other hand the type species has been observed only in the Senonian, including Møn, Stevns and Aalborg. Besides having a larger number of pores it is characterized by being much broader than var. *a*. LEVINSEN measured 4–5 mm.

Var. b is also purely Senonian in its occurrence; LEVINSEN found it in material from Møn and Aalborg. I have found it in material from the Senonian white chalk at Stevns and the two localities named, but not in Bryozoan material from the Danian. I have not subjected this variety to a close study, as it is not of interest in the present connection; I may mention, however, that its principal character is the presence of small, sporadic avicularia without pores.

Var. b has been set up by VOIGT (1930) as a new species, *Coscinopleura foliacea* VOIGT.

Here it may perhaps not be out of place to add that LEVINSEN's employment of the term "avicularium" in describing *var. a* is not quite correct, as vibracula are concerned here. As a matter of fact LEVINSEN himself arrives at this view when dealing with the type species on page 88.

LEVINSEN does not comment on the circumstance that *var. a* is apparently associated exclusively with Danian deposits, whereas the main species seems to be confined to the Senonian, despite the fact that this distribution must presumably be of stratigraphical significance.

Having regard to the above, it seemed to me to be a natural task to go into the question of the distribution of *Coscinopleura elegans* and its *var. a* from the geological and stratigraphical aspects. Unfortunately, the accessible material has not always been collected with sufficient consideration for these points of view.

The result of the investigation is that I find it reasonable to consider *var. a.* as a valid species, well defined both taxonomically and stratigraphically. I suggest for the new species the name *Coscinopleura angusta*, having regard to its most dominant character: the relative narrowness of the zoarium.

An account of the measurements taken will be given in the following section. My observations on the occurrence and appearance of the vibracula and the caenozooecia will be covered in a separate section.

Measurements.

Measurements were taken of the following parts: width of zoarium, length and breadth of zooecia, and length and breadth of vibracula.

The procedure was to select ten typical specimens from the material from each different locality, in such a manner as to have the largest and the smallest specimens included. The aforesaid measurements were made on these specimens, and the table on page 6 shows the width of the largest and smallest specimens as well as the average width of the ten specimens. I admit that ten specimens represent a very small number for average calculations; but as the number of specimens varies between about a hundred and ten, this solution was preferred in order to obtain a fairly uniform basis of appraisal. By means of examining the rest of the material I have ensured that these ten specimens really are representative. As an additional check I have made exact measurements of three hundred specimens from one locality, Herfølge. Nevertheless, although the material from a statistical point of view perhaps would seem to be insufficient, I believe it to be of some importance to present the results of my studies at this juncture. I intend later to collect further material in order to use it for testing the tenability of the views submitted in the following.

The table includes all localities from which I had material for examination. For the sake of completeness I have included foreign localities as far as the Mineralogical Museum's material will permit. In cases where the number of specimens was lower than ten an average is shown in brackets.

The table calls for the following comments:

The difference in the width of the specimens from the Senonian and the Danian is obvious at once. Regarding the Senonian, the colonies from Møn (and Rügen) have the highest average width, whereas those from Aalborg have a lower average but a greater variation of width. A larger material from the two localities will undoubtedly throw more light upon this difference.

Locality	Min. measurements	Max. measurements	Average
	mm	mm	mm
SENONIAN:			
Møn	3.57	3.91	3.74
Blegkilde, Aalborg	2.90	4.15	3.45
Stevns	2.57	3.32	2.90
Herlufmagle	1.75	2.91	2.47
Rügen (Germany)	..	..	(3.82)
Trimingham (England)	..	..	(2.44)
DANIAN:			
Voxlev (»the dead stratum«)	1.50	1.50	1.50
Korporalskroen	1.41	1.80	1.62
Stevns Klint	1.33	1.80	1.55
Kagstrup	1.50	1.66	1.60
Faxe	1.50	2.08	1.80
Lille Skensved	1.00	1.58	1.26
Herfølge	1.41	1.83	1.58
Saltholm 1	1.83	2.99	2.46
,, 2	1.25	1.66	1.44
Hesselø	1.50	1.91	1.73
Bredstrup Klint	1.58	1.99	1.80
Mønsted 1	2.08	2.24	2.18
,, 2	1.41	1.80	1.55
Klintholm, Fyn	1.66	1.99	1.84
Fæbæk Waterworks	1.00	1.16	1.06
Djævleøen, Copenhagen	1.33	1.66	1.56
Klagshamn (Sweden)	1.50	1.66	1.56
Limhamn (Sweden)	..	..	(1.66)
Crimea (Russia)	..	..	(1.50)

The average width of the specimens from Stevns and Herlufmagle is much lower than that of those from Møn and Aalborg. It would be natural to place this difference in relation to differences in facies conditions; but this assumption is not supported by a study of the colonies from Herfølge (see below), where it seems that the width is not affected by facies changes. Another explanation might lie in the different age between the white-chalk sediments of the two localities, demonstrated by TROELSEN (1937). I intend to in-

vestigate the justification of this view later when collecting supplementary material.

Taking the Senonian white chalk as a whole, it may be said that the width of the type species varies between 2 and 4 mm, specimens of greater or smaller measurement being very rare. The width of 4—5 mm stated by LEVINSEN (1925) seems to be a little too high. MARSSON (1888) gives a width variation between 1,5 and 4 mm.

As regards the Danian, as a general rule the width varies between 1 and 2 mm. I know of two exceptions, there being a few specimens from Mønsted and Saltholm with a greater width, as shown in the table. But the great majority of colonies from these localities range within the interval stated. In all other characters the deviating specimens agree with *var. a*, as will be shown later, and for this reason I have no hesitation in placing these extremely wide specimens to this variety.

In the table the Danish Danian localities are arranged according to the stratigraphical classification hitherto followed, beginning with the earliest Danian. Lastly follows the Danian localities abroad. I must emphasize the fact that I have been unable palaeontologically to distinguish between the colonies taken from the various zones of the Danian.

All the specimens from Voxlev were collected in that part of "the dead stratum" which is marked "A" in JESSEN & ØDUM'S paper (1923). "The dead stratum" superposes the Senonian white chalk and occurs immediately under the boundary flint layer, which is succeeded by Bryozoan limestone (= Danian zone B). Some of the fossils found in "the dead stratum" are Senonian others are Danian. In the present case we have to do with Danian forms. This is seen not only by the width of the colonies but also by the other elements contributing to the characteristics of the species.

The material from Korporalskroen was collected by Dr. BRÜNNICH NIELSEN, but unfortunately the labels do not show from what parts of the series the specimens came.

The only locality from which we have material from both Senonian and Danian is Stevns Klint. As will be seen from the table, the specimens from the white chalk of the Senonian age are almost twice as wide as those from the Bryozoan limestone (= zone B of the Danian).

The Bryozoan material from Kagstrup embraces the Danian zones with *Tylocidaris Ödumi*, *Tylocidaris Abildgaardi* and *Tylocidaris*

Brünnichi, but it has been impossible to see any difference between the specimens from the respective zones.

The colonies from Faxe were collected from one of the Bryozoan limestone walls in the western part of the quarry (= Danian zone C).

The Lille Skensved specimens are characterized by a very small width. It would be natural to imagine that these were zoaria not yet fully developed, but this is contradicted by the fact that several of the colonies are equipped with ovicells, quite apart from the fact that all the specimens come within the range of widths shown in the table, which would scarcely be the case if the material were composed of young as well as older and fully developed zoaria.

The same may be said of the material from Fæbæk, on Langeland. It comes from a Waterworks boring and was taken 36.4–36.6 m below ground, level about datum ÷ 18.5 (the Boring Archives of D. G. U. No. 165.23). The rock is an incoherent Bryozoan limestone which, judging from the other fossils in the boring sample, seems to belong to the upper Danian.

The specimens from Herfølge (Danian zone D) come within the limits of the Danian widths. This is very important, because from this locality the Bryozoa are known to be specially large and well-developed — a trait which has been assumed to be connected with special features of the facies there. These special features seem not to have had any influence on the zoarium width of *var. a*, so presumably the specific characters have not been subjected to variations in facies.

The Bryozoan material from Hesselø came from samples from a boring made in the autumn of 1942 (the Borings Archives of D. G. U. No. 180.1). As was the case in the North Sealand limesand area, the Bryozoa there were found within thin strata of the chalksandstone (Danian zone D), which otherwise is poor in Bryozoa. On Hesselø there were specially many Bryozoa at the following depths: 49.5–51.75 m, 64.3 m, 66.6–67 m and 72–73 m. It is remarkable to see to what extent *Coscinopleura elegans var. a* dominates in these Bryozoa-rich strata of the chalksandstone. In the Bryozoan limestone from the different zones of the Danian this variety is very frequent, but is by no means a dominant.

The locality of Klintholm, in East Funen, has not hitherto been mentioned in the literature. It consists of limestone quarries in Bryozoan limestone containing *Tylocidaris vexillifera* Schlüter *f. typica* belonging to the upper Danian. As an assistant in the Danish

Geological Survey's systematic examination of this locality, which forms part of the mapping of the pre-Quaternary and is proceeding under the leadership of THEODOR SORGENFREI, M. Sc., I have myself collected samples of the limestone for the purpose of examining the Bryozoa.

The foreign material, unfortunately, is somewhat slight; but as far as the width of the zoaria is concerned the colonies from both Scania and the Crimea seem to belong to *var. a.*

In addition to measuring the width of the zoaria I have, as already stated, measured the length and width of the zooecia. Here it was found impossible to see any distinction between the Senonian and the Danian specimens. There is only little variation in the length of the zooecia; locally one may find cells with a length of 0.52 mm, just as sometimes — but not often — there are cells of a length of 0.78 mm. The great majority, however, have a length of 0.65 mm.

As to the width of the zooecia, there are occasionally cells with a width of only 0.32 mm, but there do occur specimens measuring 0.42 mm. These extreme values are exceptional; normally the cell width ranges between 0.36 and 0.39 mm. Deviating cells are frequent where the zoaria divides. In his paper on the Bryozoa fauna in the Upper Cretaceous (1930) VOIGT states that Danian zooecia are smaller than Senonian and ascribes this difference to facies features. This view is not supported by my investigations however.

Very often the marginal vibracula are somewhat longer and broader than the zooecia, but seem to be more dependent on space conditions than the latter. However most vibracula keep within the ranges of 0.70–0.80 mm for the length and 0.38–0.40 mm for the width.

The principal result of the measurements is that in width the Senonian *Coscinopleura elegans* varies between 2 and 4 mm, whereas the Danian variety has a width of only 1–2 mm.

Vibracula and Caenozooecia.

Before proceeding with the studies I have made on the appearance and occurence of the vibracula and the caenozooecia, it may perhaps not be out of place briefly to summarize what is to be found in the litterature on these cells.

BEISSEL (1865, P. 20) designated vibracula as marginal cells and

described them as follows: The marginal cells lie in four longitudinal rows, two on each side, and form the edges of the zoarium. They join the regular cells in quincunx and differ from them by a well defined furrow and from each other by a faint one. These furrows most frequently give the marginal cells a boundary trapeziform. The frontal wall is rather convex as far as to a place in the upper part of the cell near the edge of the adjoining normal cell where it is suddenly depressed conically; here we find a round, oblique orifice from whose lower edge rises a beak-shaped, everted lip. The entire frontal wall is pierced like a sieve with fine pore-ducts. Between two of these marginal cells, where at the edge they do not adjoin, lies a small almost triangular marginal cell; by this means the edge of the colony becomes quite even. These small marginal cells are separated from the other adjacent marginal cells by extremely faint furrows, and the frontal-wall behind these furrows usually sinks towards the centre, where it is pierced by a round orifice.

Beissel considered this cell to contain a vibraculum, the round orifice being too small to hold an avicularium.

According to Marsson (1888), the marginal cells must be a special kind of vibracula. Between them are small triangular and irregularly polygonal cells having a pore in the centre. Levinsen (1925) also considers the perforated marginal zooecia to be vibracula.

In their large work on the Tertiary Bryozoa of North America (1920) Canu & Bassler, when describing the family *Coscinopleura*, say that the caenozooecia must be regarded as hydrostatic zooecia. Later, however, they drop this opinion, for in the paper on the Bryozoa in Vincentown Limesand (1933) they state that the caenozooecia must be regarded as being too small to be of any significance as the hydrostatic regulators of the colony.

As was stated in the Introduction, Levinsen (1925) writes that one of the characters separating var. *a* from the main species is that the variety has fewer pores than the latter. I have gone into this question, but my analyses resulted in new observations of interest in this connection; these will be dealt with in the following.

I found that contrary to what appears from earlier illustrations of *Coscinopleura elegans*, the pores in the vibracula are not spread accidentally over the frontal-wall. It is always possible to distinguish a row of pores along each lateral margin of the vibracula, as shown in the accompanying illustrations. The Senonian specimens have sex or seven pores, whereas those from the Danian have only four

along each edge. Further, the Senonian colonies have a large number of pores scattered about the frontal-wall, the Danian only two or three.

On examining the structure of the margin of the zoarium we see that the appearance and distribution of the caenozooecia on the Senonian specimens are much more complicated that is the case with the Danian specimens. This will appear from the following illustrations and the accompanying description.

Senonian Forms of *Coscinopleura elegans* (VON HAGENOW).

The distribution of vibracula and caenozooecia on a specimen from Møen is shown in fig. 1. The drawing on the right shows caenozooecia, vibracula and one row of zooecia, while the drawing on the left is an illustration of the cell distribution on both sides of the edge. The enlargement is 20 x. (This principle arrangement and enlargement is used in all the illustrations).

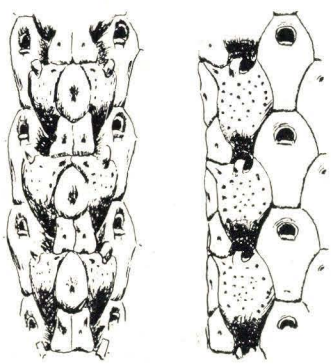

Fig. 1.

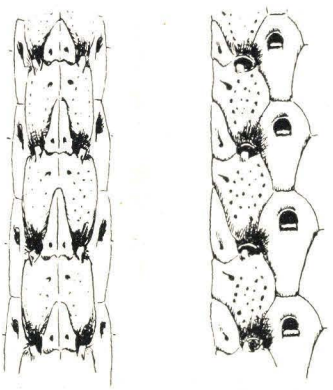

Fig. 2.

It will be seen how paired caenozooecia alternate with unpaired ones. On the vibracula is the above-mentioned distribution of the pores, with six or seven along each edge and numerous others spread over the frontal-wall. In the upper part of the vibracula towards the edge of the zoaria it will be observed how the corner, which is bordered by sharp edges, is wedged in between the adjoining caenozooecia. In this corner is an oval, oblique pore. This feature is characteristic of the type species and has not been met with in the Danian colonies. It is seldom that the distribution stands out

so clearly as on this specimen; in most cases the encrusting of the cells is much more advanced, though the individuals can always be distinguished by close study. This type is very common in the Senonian white chalk from the localities named.

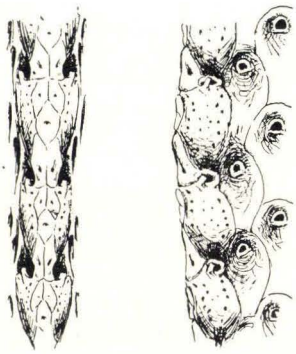

Fig. 3.

Another type is also frequent. It is shown in fig. 2.

It will appear from the illustration that all the caenozooecia inthis type are paired.

A third form deviates only little from type 1; it has both paired and unpaired caenozooecia, but the system of distribution is for two sets of paired caenozooecia to alternate with one unpaired set, as shown in fig. 3. This distribution has been observed in a number of Danish specimens from the Senonian and in the two solitary specimens I have from Rügen and Trimingham.

Danian Forms of *Coscinopleura elegans (von Hagenow) var. a. (Levinsen).*

As I have pointed out, Danian colonies lack the prominent upper corner with the oblique pore of the vibracula. Ther are other differences too. Most og the specimens examined are characterized by the fact that the caenozooecia occur singly between the vibracula, as shown in fig. 4.

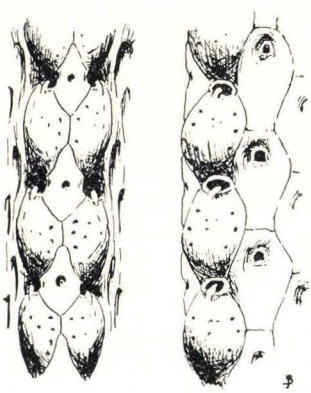

Fig. 4.

On fig. 4 will also be seen the feature previously referred to: that there are only four pores along each lateral margin and two or three pores in the middle of the frontal-wall.

As was stated in the section on measurements, there are specimens from Mønsted and Saltholm with width exceeding those normalized for the Danian colonies: 1–2 mm. All these specimens, however, have only four pores along each of the lateral margins of the vibracula; in addition, the upper prominent corner with its oblique pore is absent, and the

edge of the zoaria is formed of caenozooecia and vibracula in the manner shown in fig. 4. In spite of the difference in the width, these features must be regarded as sufficing to enable these colonies also to be placed to the var. *a* that is characteristic of the Danian.

Conclusion.

In the section on vibracula and caenozooecia I have enumerated various characters by means of which *Coscinopleura elegans var. a* differs from the type species *Coscinopleura elegans* (VON HAGENOW). On comparing these characters with the differences in the width and the stratigraphical distinction, I consider it justifiable to set up var. *a* as an distinct species. For this species I propose the name *Coscinopleura angusta* n. sp.

Coscinopleura angusta n. sp. is characterized by the following characters: The zoarium is about 1–2 mm wide; the vibracula have only four pores along each lateral margin and two or three pores in the middle of the frontal-wall; the upper marginal corner of the vibracula is rounded, not prominent, and lacks the oblique pore found there on *Coscinopleura elegans* (VON HAGENOW); the edge of the zoarium is mostly formed of vibracula, between which are unpaired caenozooecia. In respect of most other characters *Coscinopleura angusta* very closely approaches *C. elegans*.

Finally, these studies must be regarded as preliminary. Before we can clarify the appearance and geological occurrence of the two species a good deal more material must be collected from both the Senonian and the Danian. It would also be advisable to arrange these comparative studies so as to include the American species *Coscinopleura digitata* MORTON.

Holotype of Coscinopleura angusta n. sp. (Fig. 4) in the collections of the GEOLOGICAL SURVEY Charlottenlund, Denmark.

Resumé.

Studier over Bryozoerne Coscinopleura elegans og Coscinopleura angusta n. sp. i danske Senonien og Danienaflejringer.

LEVINSEN har i sin afhandling: Bryozoerne i den danske kridtformation (1925), under omtalen af *Coscinopleura elegans* anført to varieteter *a* og *b*. Hovedarten og *var. b* er rent senone i deres optræden, mens *var. a* kun kendes fra Danienet.

I nærværende fremstilling er hovedarten og *var. a* gjort til genstand for sammenlignende studier, mens *var. b* ikke er blevet behandlet nærmere.

Der er foretaget maalinger af stammebredden samt bredde og længde af zooecier og vibracularceller hos de to former. Resultatet af disse maalinger er anført i tabellen side 6, og gaar i korte træk ud paa, at stammernes breddevariation hos hovedarten ligger mellem 2 og 4 mm, hos *var. a* mellem 1 og 2 mm.

Endvidere er vibracularcellernes og kænozooeciernes udseende og fordeling gjort til genstand for nærmere undersøgelse, hvorved følgende resultater er opnaaet:

1. Porerne i vibracularcellerne er ikke, som det fremgaar af tidligere illustrationer af *Coscinopleura elegans*, tilfældigt spredt over celledækket. Der vil altid kunne adskilles en række porer langs hver af vibracularcellens laterale rande. De senone eksemplarer har seks-syv porer langs hver rand og et stort antal spredt over celledækket, mens eksemplarerne fra Danienet har fire porer langs hver side og to-tre porer fordelt over celledækket.

2. Kænozooeciernes udseende og fordeling hos hovedarten er vist paa fig. 1—3. Der kan skelnes mellem tre typer. Fig. 4 illustrerer tilsvarende forholdene hos var. *a*.

3. Paa fig. 1—3 vil man endvidere se, hvorledes det øverste, mod kanten vendende, hjørne af vibracularcellen kiler sig ind mellem de tilgrænsende kænozooecier og er forsynet med en skraatstillet pore. Dette forhold kendes ikke hos *var. a*.

De nævnte tre karaktertræk og den anførte breddeforskel samt adskillelsen i stratigrafisk henseende synes tilstrækkeligt grundlag for at opstille *var. a* som selvstændig art, til hvilken foreslaas navnet *Coscinopleura angusta* n. sp.

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