THE BELEMNITES AND THEIR STRATIGRAPHICAL SIGNIFICANCE

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The majority of the belemnites from the Särdal beds were collected loose, but on the basis of the adherent matrix it has been possible to assign about half of the determinable specimens either to the derived phosphatised rock-fragments, to the lower limestone, or to the upper sandstone. A survey of the number of specimens of the belemnite species is given in table 5.

The Santonian belemnite faunas from the limestone and the sandstone are almost identical, only differing in the presence of one specimen of *Actinocamax verus* in the sandstone and five specimens of *Gonioteuthis lundgreni* in the limestone, but this difference is probably due to the overall rarity of the two species in these deposits. Because no significant differences in the composition of the two belemnite faunas were found, the specimens of *Gonioteuthis westfalica westfalica* and *Belemnitella propinqua propinqua* from the limestone and the sandstone are lumped together with the specimens of unknown stratigraphic position in the statistical analyses.

The belemnites are rather corroded, and only the major surface texture, such as dorso-ventral double furrows and lateral furrows, is still visible.

The belemnite fauna from the limestone and the sandstone is very similar to the belemnite fauna from the Bavnodde Greensand on the island of Bornholm (Denmark), part of which was described recently by Christensen (1971), and comparisons with that fauna have therefore been carried out.

The belemnites from the Bavnodde Greensand were placed at the author's disposal by the Mineralogical Museum, Copenhagen, (MMH), and from Mr. S. Bo Andersen's private collections. Specimens of *B. propinqua propinqua* from the Eriksdal Marl were given to the author by the Geological Survey of Sweden, Stockholm, (SGU), and the Swedish Museum of Natural History, Section of Palaeozoology, Stockholm, (RM). The author wishes to thank Dr. R. Skoglund (SGU), Dr. V. Jaanusson (RM), S. Floris, M. Sc. (MMH), and Mr. S. Bo Andersen for the loan of the investigated belemnite material. Casts of *G. lundgreni* from the Münster Basin in Germany were sent to the author through the courtesy of Dr. F. Schmid, Hannover, and Dr. G. Ernst, Braunschweig.

Survey of the number of specimens of the belemnite species from the Särdal beds	Specimens from the derived phosphatised rock fragments	Specimens from the limestone	Specimens from the sandstone	Specimens of unknown stratigraphic position	Number of specimens
B. propinqua propinqua	0	11	31	48	90
G. westfalica westfalica	0	23	46	61	130
G. lundgreni	0	5	0	4	9
A. verus	0	0	1	6	7
A. ex gr. *primus/plenus*	1	0	0	2	3
A.? sp. indet.	3	0	0	0	3
Undeterminable specimens	6	34	9	90	139
Total number of specimens	10	73	87	211	381

Table 5. A survey of the number of specimens of the belemnite species from the Särdal beds.

Statistical methods and terms

In the present study monovariate and bivariate statistical analyses of the belemnite species have been made in order to study the variation of different characters within a species and to compare samples with each other.

The monovariate analysis

The estimates of the following statistics have been computed: mean value ($\bar{X}$), standard deviation (SD), coefficient of variation (CV). Furthermore, the observed range (OR) is mentioned and N is the number of specimens.

The mean values of two samples have been compared by the t-test. It may be worth mentioning that the underlying assumptions for this test are that the measurements are normally distributed and the variances of the two samples are equal, (Simpson et al. 1960, pp. 183–184). According to Simpson et al. (loc. cit.) the t-test is very robust and can be applied even if the measurements are not normally distributed. Therefore, only the variances have been tested for equality by the F-test in the present study.

The bivariate analysis

Regression analyses have been made to study the relative growth. Different methods for fitting a straight line exist, and if the scatter diagram shows a linear trend on ordinary graph paper the calculation of a straight line ($y = a + bx$) can be done in a least five ways:

1) "the least square method" (y on x),
2) "the least square method" (x on y),
3) "the major axis method",
4) "the reduced major axis method",
5) "Bartlett's best fit line method".

If the scatter diagram shows a curvilinear trend on ordinary graph paper a straight line can in most cases be fitted by using the log-values in the same five ways. This means that the relative growth follows the equation, $y = bx^a$, because $\log y = \log b + a \log x$. The underlying assumptions for the equation $y = bx^a$ (often called the equation of simple allometry) are as follows: 1) the growth must be multiplicative, and 2) the ratio between the multiplicative growth rates of the characters y and x remains constant during the growth of the organism. The fitting methods mentioned above have been discussed by Kermack & Haldane (1950), Kermack (1954), Imbrie (1956), Simpson et al. (1960), Gould (1966), Miller & Kahn (1962), Ghose (1970), and Hayami & Matsukama (1970), to mention only a few.

All the scatterdiagrams figured in the present paper show a linear trend on ordinary graph paper, and a straight line is computed by "the least square method" for reasons given below. It may be worth remembering that only a straight line through the origin represents isometric growth. In this case the equation can be written $y = bx$, and the ratio between y and x is constant, while the equations, $y = a + bx$ and $y = bx^a$, both represent allometric growth.

"The major axis method" cannot be recommended as it is not invariant under a change of scale (Kermack & Haldane, 1950, p. 30). "The reduced major axis method" has in recent years been preferred by many authors because neither of the characters is taken as dependent upon the other. The method is very suitable for finding the structural relationship between the two variates but it seems to have some drawbacks in comparing two growth curves computed after this method. Thus, Miller & Kahn (1962,

p. 206 footnotes 1 and 2) pointed out that it is not possible to make an objective comparison between two growth curves by this method, and that the method does not test the variances of the growth curves for equality. Furthermore, Simpson et al. (1960) stated that this method cannot be recommended as no exact confidence intervals for the slope (b) can be calculated. However, they recommended "Bartlett's best fit line method", which is close to the "reduced major axis method", but according to their own statements (p. 237), it is not possible to make exact comparisons between the slopes and the y-intercepts of two growth curves by this method. Therefore, in the present study the growth curves have been computed after "the least square method", even if this method has the drawback that one of the characters must be regarded as dependent upon the other. This drawback is counterbalanced by the very fact that it is possible to compare two growth curves objectively and exactly. In cases where the correlation between the variates is high, "the least square method" and "the reduced major axis method" give almost identical results (Gould, 1966, p. 600).

The growth curves of the two samples have been compared in the way described by Hald (1957, § 18.8, pp. 571–579). The procedure consists of three steps. First, the variances are tested for equality by the F-test. If the test shows that the variances do not differ significantly, we can proceed and compare the slopes of the two growth curves by the t-test. If the slopes do not differ significantly a mean slope is calculated, and the position of the two parallel lines is compared by a t-test.

In those regression analyses where the length of the guard is the one variate, this character is considered as the independent variate on the ground that the length of the guard reflects the age of the animal; a large specimen is considered as a full-grown belemnite, although variation within a certain age-group presumably occurs.

In the bivariate analyses the estimates of the following statistical parameters have been computed: the slope (b), the standard deviation of the slope (SD_b), the intercept on the y-axis (a), the standard deviation of the intercept on the y–axis (SD_a), the correlation coefficient (r), the variance of the regression line (SD^2_{yx}), and the standard deviation of the regression line (SD_{yx}).

Ratios

The use of ratios is widespread in palaeontological studies, but it has some disadvantages which have been discussed, notably, by Shaw (1956, pp. 1212–1214), Simpson et al. (1960, pp. 13–19), and Sokal (1965, pp. 345–346). First, the ratio is a secondary statistic which has a greater variance than the measurements of which it is composed. Second, in cases where the relationship between the two variates on which the ratios are based is allometric the ratio will change during the growth of the animal. Thus, Shaw (loc. cit) showed that there was a statistically significant difference between the mean ratios of the ten smallest and the ten largest specimens of the trilobite, *Parabolinella triarthroides*; the ratios were based on the occipital glabellar length divided by the intramarginal cranidial length. Therefore, the use of ratios must in such cases be rejected. In the opinion of the author ratios can be used with advantages in those instances only where a small number of specimens is available which prevents bivariate analysis.

Terms

The "Schatzky-Index" was introduced by Jeletzky (1949 a, p. 260, footnote 2) and is defined as the distance from the protoconch to the beginning of the bottom of the ventral fissure measured along the longitudinal axis. It appears from the definition that the "Schatzky-Index" is not an index, and the following term Schatzky-Distance is therefore proposed for this character.

The Riedel-Quotient was introduced by Ernst (1964, p. 122) and is defined as the ratio between the length of the guard and the depth of the pseudoalveolus.

The Schlankheits-Quotient was likewise introduced by Ernst (1964, table 2) and is defined as the ratio between the length of the guard and the dorsoventral diameter at the alveolar end.

The fissure angle is the angle between the wall of the alveolus and the straight line which connects the intersection points of the bottom of the ventral fissure on the wall of the alveolus and the outer margin of the guard.

The term conella is used for the cone-shaped tubercle in the alveolus of belemnites (Hölder, 1955).

Systematic description

Belemnitellidae Pavlov, 1914
Belemnitella D'Orbigny, 1840
Belemnitella propinqua propinqua (Moberg, 1885)
Pl. 9, figs 1–5; pl. 10, figs 1–3.

Synonymy: A detailed list of synonyms is given in Christensen (1971).

Material: 90 specimens, 4 of which are complete. Figured specimens MMH 12730–12737.

Short description: A *Belemnitella* with a rather sturdy guard, lanceolate in ventral view and slightly lanceolate or subcylindrical in lateral view. The cross-section of the pseudoalveolus at the alveolar end is subtriangular to pointed oval with the dorso-ventral diameter exceeding the lateral diameter. The walls of the pseudoalveolus are covered by conellae. The Riedel-Quotient varies from a little less than three to about four, and the Schatzky-Distance is 3 to 8 mm, with a mean value about 5 mm.

Remarks: A detailed description of *B. propinqua propinqua* based on 13 specimens from the Bavnodde Greensand and 3 specimens (including the holotype) from the Eriksdal Marl was given in Christensen (1971). In that paper it was shown that the concept of *B. propinqua propinqua* was misinterpreted by Russian palaeontologists and that some of the specimens from the Russian Platform referred to as *B. propinqua propinqua* should be excluded from that species. The 16 specimens of *B. propinqua propinqua* collected during the last hundred years represent the total number of specimens known from Scandinavia until the Särdal beds were excavated. Therefore the large number of specimens from the Särdal beds is most interesting, and it is now possible to give a detailed analysis of the variation of that species.

Biometry: Four complete specimens from the Särdal beds have a Riedel-Quotient which is 3.53—3.18—3.91—2.76. This corresponds very well with the specimens from the Bavnodde Greensand and the Eriksdal Marl (Christensen, 1971, p. 371). The estimates of $\bar{X}$, SD, CV, and the OR of the following characters: the Schatzky-Distance, the fissure-angle, and the length from apex to the protoconch, are given below.

B. propinqua propinqua from the Särdal beds:

	N	$\bar{X}$	SD	CV	OR
Schatzky-Distance in mm	24	5.4	0.82	15.4	3.7–6.7
Fissure-angle in degrees	27	16.8	6.54	39.0	10.0–33.0
Length from apex to the protoconch in mm	17	40.1	7.54	18.8	28.9–57.6

B. propinqua propinqua from the Bavnodde Greensand:

	N	$\bar{X}$	SD	CV	OR
Schatzky-Distance in mm	4	4.6	0.62	13.6	3.7–5.1
Fissure-angle in degrees	3	12.3	5.49	44.5	7.5–18.0
Length from apex to the protoconch in mm	8	55.8	11.54	20.7	41.6–68.8

B. propinqua propinqua from the Eriksdal Marl:

	Schatzky-Distance in mm	Fissure-angle in degrees	Lenght from apex to the protoconch in mm
Holotype	3.1	11.5	58.0
Specimen No. 2	5.1	6*	53.7
Specimen No. 3	est. 5	10*	–

* The fissure-angle cannot be measured with certainty as the anterior end of the guard is broken off.

The great variation in the fissure-angle for the sample from the Särdal beds and the Bavnodde Greensand should be noted. Also the bottom of the ventral fissure is highly variable, and it can be almost straight, s-shaped, curved, or slightly bent, (see pl. 9, figs 1 c, 2 b, 4 b; pl. 10, fig. 1–3).

The specimens from the Särdal beds differ from the specimens from the Bavnodde Greensand and the Eriksdal Marl in being smaller in size. The mean values of the length from apex to protoconch of the samples from the Särdal beds and the Bavnodde Greensand have been compared after the F-test had showed that the variances can be considered equal. The t-test with 23 degrees of freedom gave $t = 4.1050$, which is highly significant ($P < 0.1$ %).

Dorso-ventral diameter at the protoconch (x) versus lateral diameter at the protoconch (y): A regression analysis of the sample from the Särdal beds gave the following result (fig. 4):

$$y = -0.1673 + 1.017x;\quad r = 0.9685;\quad N = 35;\quad SD_{yx} = 0.4741;$$

The correlation coefficient with 33 degrees of freedom is highly significant ($P < 0.1$ %). A t-test of the intercept on the y-axis gave $t = 0.3635$ with 33 degrees of freedom, which is not significant ($80\,\% > P > 70\,\%$).

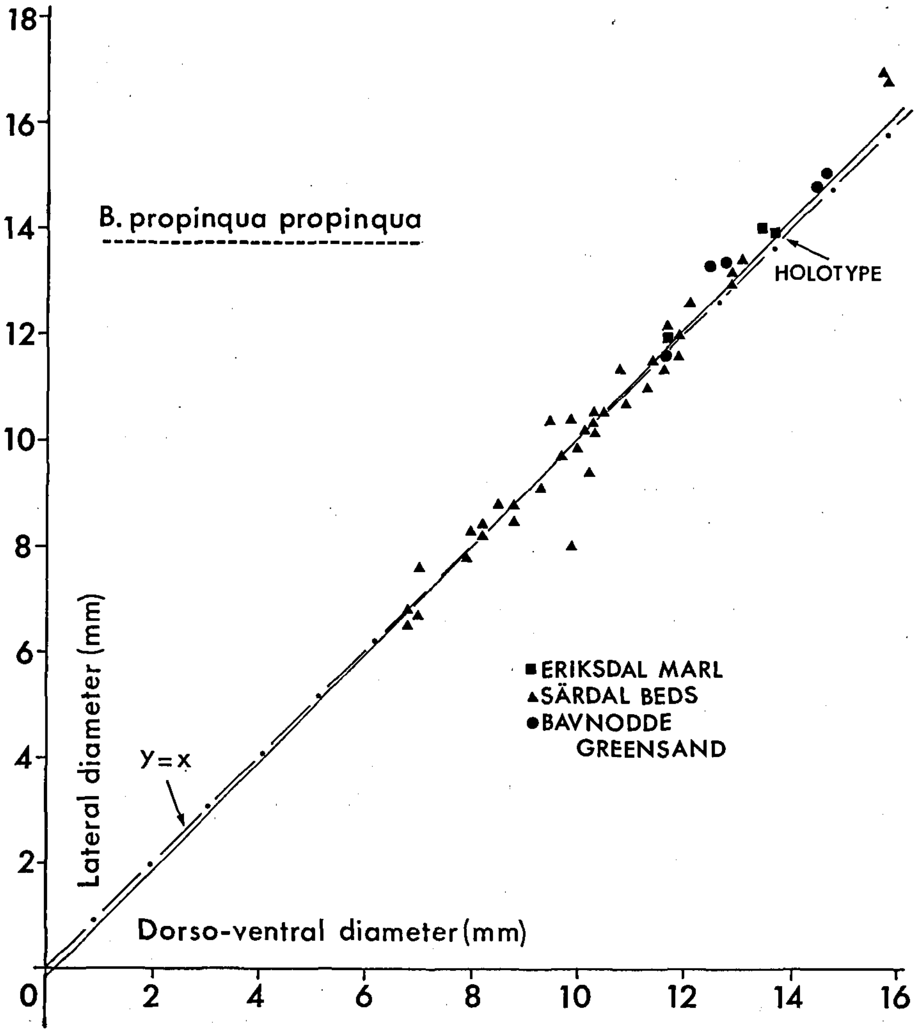


Fig. 4. Scatterdiagram and growth curve of the dorso-ventral and the lateral diameter at the protoconch for *B. propinqua propinqua* from the Särdal beds. The specimens of *B. propinqua propinqua* from the Bavnodde Greensand and the Eriksdal Marl are also shown.

Therefore, the relative growth can be considered isometric. A t-test was made to see if the computed value of the slope differs from unity. The t-test gave t = 0.3754 with 33 degrees of freedom, which is not significant (80 % > P > 70 %). As a consequence of the two t-tests the equation for the growth curve of the dorso-ventral diameter and the lateral diameter

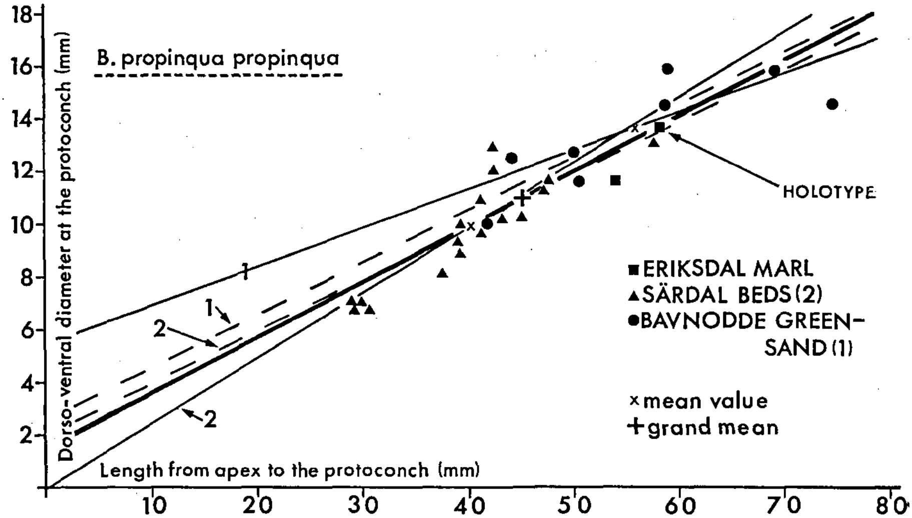


Fig. 5. Scatterdiagram and growth curves for *B. propinqua propinqua* from the Särdal beds and the Bavnodde Greensand. The two specimens from the Eriksdal Marl are also shown. The heavy black growth curve is based on the specimens from the Särdal beds and the Bavnodde Greensand.

at the protoconch can be written: y = x. This does of course only mean that the cross-section at the protoconch can be inscribed in a square, and it says nothing about the form. In the scatterdiagram the specimens from the Bavnodde Greensand and the Eriksdal Marl are also shown.

Length from apex to the protoconch (x) versus dorso-ventral diameter at the protoconch (y). The scatterdiagram for the specimens of *B. propinqua propinqua* from the Särdal beds, the Bavnodde Greensand, and the Eriksdal Marl are shown in fig. 5. Regression analyses gave the following results:

B. propinqua propinqua from the Särdal beds:

$y = -0.1283 + 0.2485x$; $r = 0.8971$; $N = 17$; $SD_{yx} = 0.9525$;

The correlation coefficient with 15 degrees of freedom is highly significant ($P < 0.1\,\%$).

B. propinqua propinqua from the Bavnodde Greensand:

$y = 5.3607 + 0.1451x$; $r = 0.8007$; $N = 8$; $SD_{yx} = 1.3530$;

The correlation coefficient is significant ($2\,\% > P > 1\,\%$).

The growth curves have been compared in the way described on p. 116. The test for equality of the variances gave F = 2.0177 with 6 and 15 degrees of freedom, which is not significant (P > 20 %). The t-test of the slopes gave t = 1.1258 with 21 degrees of freedom, which is not significant (30 % > P > 25 %). The estimate of the mean slope is calculated as $\bar{b}$ = 0.1962, and the two parallel growth curves can now be written:

the Särdal beds: $y = 1.9705 + 0.1962x$;
the Bavnodde Greensand: $y = 2.5095 + 0.1962x$;

The test of the position of the growth curves gave t = 0.8810 with 21 degrees of freedom, which is not significant (40 % > P >30 %). This means that the calculated growth curves can be considered as estimates of the same theoretical growth curve. An estimate of this growth curve is calculated by lumping the specimens from the Särdal beds and the Bavnodde Greensand together. This analysis gave the following result:

$y = 1.4459 + 0.2114x$; $r = 0.9174$; $N = 25$; $SD_{yx} = 1.0801$;

The correlation coefficient with 23 degrees of freedom is highly significant (P < 0.1 %). The computed growth curve based on the specimens from the Bavnodde Greensand and the Särdal beds is shown in heavy black in fig. 5.

It can be concluded from the statistical analyses that the only difference between the specimens from the Särdal beds and the Bavnodde Greensand is the mean length from apex to the protoconch. A difference in size seems to the present author to be of little taxonomic value, and further studies on *B. propinqua propinqua* from other localities will have to be made before this character can be considered to be of taxonomic significance.

Geographical distribution: *B. propinqua propinqua* has so far only been found in Scandinavia and on the northeastern part of the Russian Platform (Christensen, 1971). In Scandinavia it has been found in the Särdal beds, in the Bavnodde Greensand, in the Eriksdal Marl, and in the Kullemölla-boring (Lundgren, 1935) at the level 248 m (author's unpublished result). One specimen from the locality Gräsryd in the Båstad area (Moberg, 1885, p. 53) examined by the author may be referred to the subspecies.

Stratigraphical distribution: According to Christensen (1971) *B. propinqua propinqua* occurs in Scandinavia from the uppermost part of the Lower Santonian to the boundary between the lower and upper part of the Middle

Santonian (cf. stratigraphical diagram on p. 130). According to Jeletzky (1958, Vergleichtabelle) *Belemnitella* ex gr. *mirabilis* Arkhangelsky sensu Jeletzky (= *B. propinqua propinqua)* has its main occurrence in the Dniepr-Donez Basin (= Ukrainian Syneclise of Naidin, 1960) in the same stratigraphical interval.

Gonioteuthis Bayle, 1879

Gonioteuthis westfalica westfalica (Schlüter, 1874)

Pl. 9, figs 6–7; pl. 10, figs 4–5

Synonymy: A list of synonyms is given in Naidin (1964).

Material: 130 specimens, 24 of which are complete. Figured specimens MMH 12738–12741.

Short description: A *Gonioteuthis* with a rather small guard; lanceolate in ventral view and slightly lanceolate or subcylindrical in lateral view. The calcification of the anterior end of the guard is highly variable and results in specimens with a low cone-shaped alveolar fracture with a small pit in its centre to specimens with a shallow pseudoalveolus, with all intermediate forms (cf. pl. 9, figs 6–7; pl. 10, fig. 4). The cross-section of the pseudoalveolus is ovate to subtriangular, and the edge of the pseudoalveolus is often provided with a dorsal notch.

Remarks: The species is closely related to known species of the genus *Actinocamax* Miller but is placed in the genus *Gonioteuthis* for the following reasons (cf. Ernst, 1964, pp. 159–160): 1) some of the specimens possess a real ventral fissure or a fissure-like furrow, 2) the species must be considered as the first member in the evolutionary lineage: *G. westfalica*—*G. granulata*—*G. quadrata* —*G. quadrata gracilis*.

The genus *Gonioteuthis* from northern Germany has been carefully studied in recent years by Ernst (1963a, 1963b, 1964, 1966, 1968) and provides a good tool for stratigraphical purposes. Unfortunately, Ernst uses ratios, such as e. g. Riedel-Quotient and Schlankheits-Quotient, even if some of his scatterdiagrams indicate an allometric relationship of the variates (cf. discussion of ratios on p. 116 in the present paper). Therefore, instead of calculating ratios, regression analyses between the pairs of variates were made.

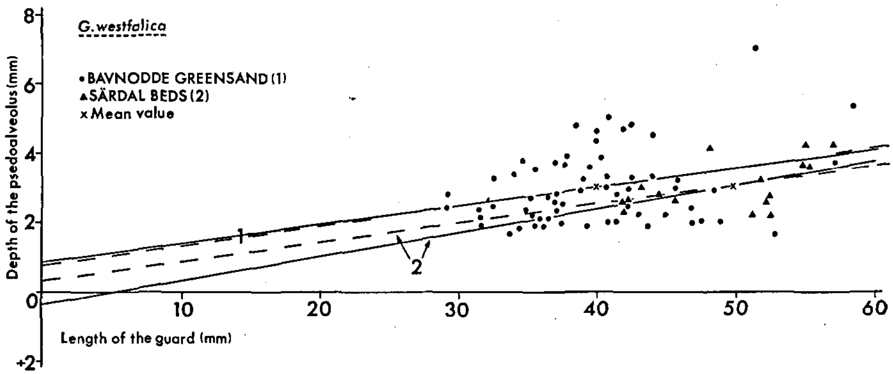


Fig. 6. Scatterdiagram and growth curves for *G. westfalica westfalica* from the Särdal beds and the Bavnodde Greensand.

Biometry: 16 specimens of *G. westfalica westfalica* from the Särdal beds were used in the biometrical analyses; 8 complete specimens were found after the calculation has been made. The sample of *G. westfalica westfalica* from the Bavnodde Greensand was collected by Mr. S. Bo Andersen, and it is the same sample as employed in Christensen (1971).

Length of the guard (x) versus the depth of the pseudoalveolus (y):—The scatterdiagram for the sample from the Särdal beds and the Bavnodde Greensand is shown in fig. 6. The regression analyses gave the following results:

G. westfalica westfalica from the Särdal beds:

$y = -0.3553 + 0.0686x;\ r = 0.5249;\ N = 16;\ SD_{yx} = 0.6178;$

The correlation coefficient with 14 degrees of freedom is significant ($5\% > P > 2\%$).

G. westfalica westfalica from the Bavnodde Greensand:

$y = 0.8633 + 0.0527x;\ r = 0.3017;\ N = 64;\ SD_{yx} = 1.0219;$

The correlation coefficient with 62 degrees of freedom is significant ($2\% > P > 1\%$).

From the scatterdiagram it is clear that there is a difference in the mean length of the guard between the two samples. The mean length of the guard is 49.3 mm for the sample from the Särdal beds and 39.9 mm for the sample from the Bavnodde Greensand. The F-test showed that the variances can be considered as equal and the t-test was carried out. The test gave

$t = 5.6688$ with 78 degrees of freedom, which is highly significant ($P < 0.1$ ‰). It should be stressed that in the case of *G. westfalica westfalica* the sample from the Särdal beds is significant larger in the size of the guard than the sample from the Bavnodde Greensand, while in the case of *B. propinqua propinqua* it is the other way about (cf. p. 119). These differences in size may be due to environmental conditions (see also p. 130).

The growth curves have been compared with the following results. The F-test of the variances gave $F = 2.7361$ with 62 and 14 degrees of freedom, which is significant at the 5 ‰-level (5 ‰ $> P >$ 2 ‰). As the difference between the variances is not highly significant is was decided to continue and test the slopes of the growth curves. The t-test gave $t = 0.3162$ with 76 degrees of freedom, which is not significant (80 ‰ $> P >$ 70 %). The mean slope was calculated as $\bar{b} = 0.0552$, and the two parallel growth curves can now be written:

the Särdal beds: $y = 0.3076 + 0.0552x$;
the Bavnodde Greensand: $y = 0.7641 + 0.0552x$;

The t-test of the position of the growth curves gave $t = 1.2667$ with 76 degrees of freedom, which is not significant (30 ‰ $> P >$ 25 ‰). It can therefore be concluded that the two growth curves can be considered as estimates of the same theoretical growth curve. The estimate of this curve has not been calculated, but it will be very close to the growth curve for the sample from the Bavnodde Greensand.

The pattern of the scatterdiagram of the length of the guard and the depth of the pseudoalveolus for *G. westfalica westfalica* from the Bavnodde Greensand and the Särdal beds is very characteristic of that species, and has been found for *G. westfalica* from the other localities.

Calculations of t-tests on the y-intercept showed that the relationship between the length of the guard and the depth of the pseudoalveolus in the two samples can be considered as isometric.

Length of the guard (x) versus dorso-ventral diameter at the alveolar end (y):

The scatterdiagram for the samples from the Särdal beds and the Bavnodde Greensand is shown in fig. 7. The regression analyses gave the following results:

G. westfalica westfalica from the Särdal beds:

$y = -4.6578 + 0.2405x$; $r = 0.8588$; $N = 16$; $SD_{yx} = 0.7962$;

G. westfalica westfalica from the Bavnodde Greensand:

$y = -2.8289 + 0.1980x$; $r = 0.9205$; $N = 64$; $SD_{yx} = 0.5153$;

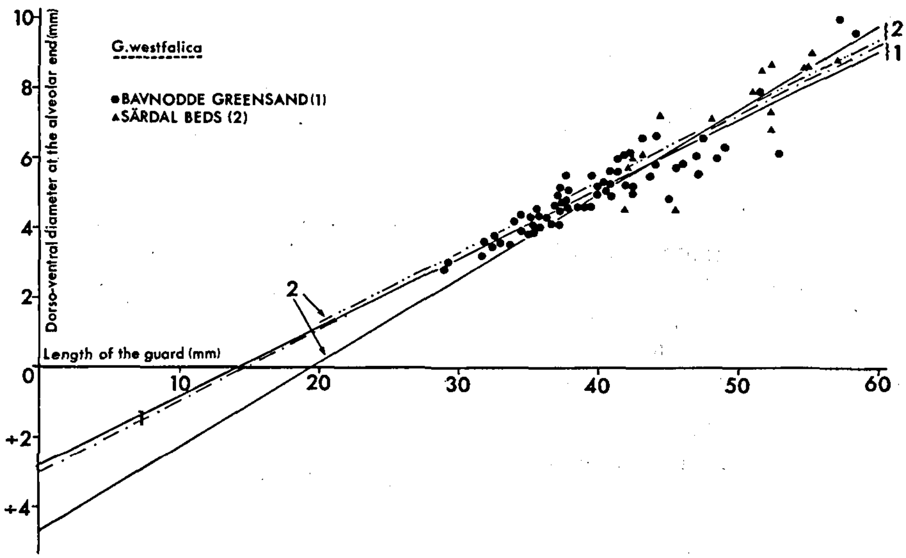


Fig. 7. Scatterdiagram and growth curves for *G. westfalica westfalica* from the Särdal beds and the Bavnodde Greensand.

The correlation coefficient of both samples are highly significant (P < 0.1 %)

The growth curves have been compared with the following results. The test for equality of the variances gave F = 2.3877 with 14 and 62 degrees of freedom, which is significant at the 5 %-level (5 % > P > 2 %). As the difference is not highly significant it was decided to continue and test the difference of the slopes. This test gave t = 1.4050 with 76 degrees of freedom, which is not significant (30 % > P > 25 %). The estimate of the mean slope is computed as $\bar{b}$ = 0.2046, and the growth curves can now be written:

the Särdal beds: $y = -2.8870 + 0.2046x$;
the Bavnodde Greensand: $y = -2.9936 + 0.2046x$;

The test of the position of the growth curves gave t = 1.0785 with 76 degrees of freedom, which is not significant (30 % > P > 25 %). Therefore, the computed growth curves can be considered as estimates of the same theoretical growth curve, which is very close to the growth curve from the sample from the Bavnodde Greensand.

It should be noted that the relationship between the two variates is allometric. A t-test on the intercept on the y-axis of the sample from the Bavnodde Greensand gave t = 6.5687 with 62 degrees of freedom, which

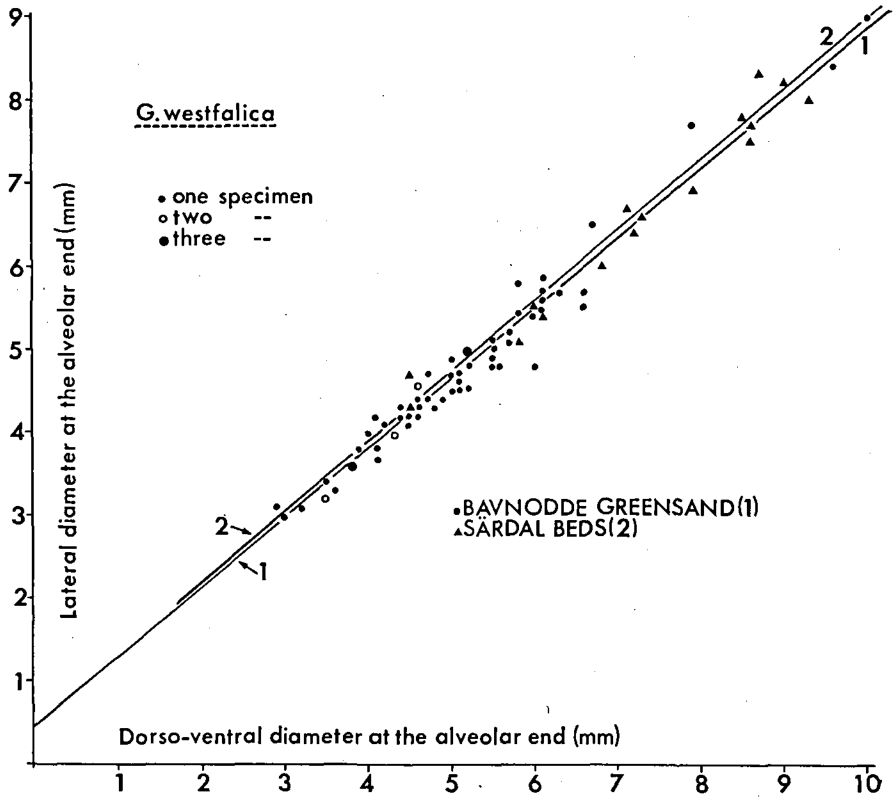


Fig. 8. Scatterdiagram and growth curves for *G. westfalica westfalica* from the Särdal beds and the Bavnodde Greensand.

is highly significant ($P < 0.1$ ‰). This means that the ratio between the variates will change during the growth of the belemnite; a young specimen will be comparatively more slender than an adult specimen.

Dorso-ventral diameter at the alveolar end (x) versus lateral diameter at the alveolar end (y): The scatterdiagram of the two samples is shown in fig. 8. The equations of the growth curves are:

the Särdal beds:
$y = 0.4509 + 0.8490x$; $r = 0.9842$; $N = 16$; $SD_{yx} = 0.2370$;

the Bavnodde Greensand:
$y = 0.4288 + 0.8442x$; $r = 0.9806$; $N = 64$; $SD_{yx} = 0.2228$;

The correlation coefficient of both samples are highly significant ($P < 0.1$ ‰).

The growth curves can be considered as estimates of the same theoretical growth curve as no significant differences in the variances, the slopes, and the positions could be shown. Calculation of t-test on the y-intercept of the sample from the Bavnodde Greensand gave t = 3.8193 with 62 degrees of freedom, which is highly significant ($P < 0.1\,\%$). This indicates an allometric relationship. In the sample from the Särdal beds the t-test on the y-intercept gave t = 1.5047 with 14 degrees of freedom, which is not significant ($20\,\% > P > 10\,\%$). The reason why the sample from the Särdal beds indicates an isometric relationship may be the small number of specimens, which does not allow the growth curve to be determined so accurately.

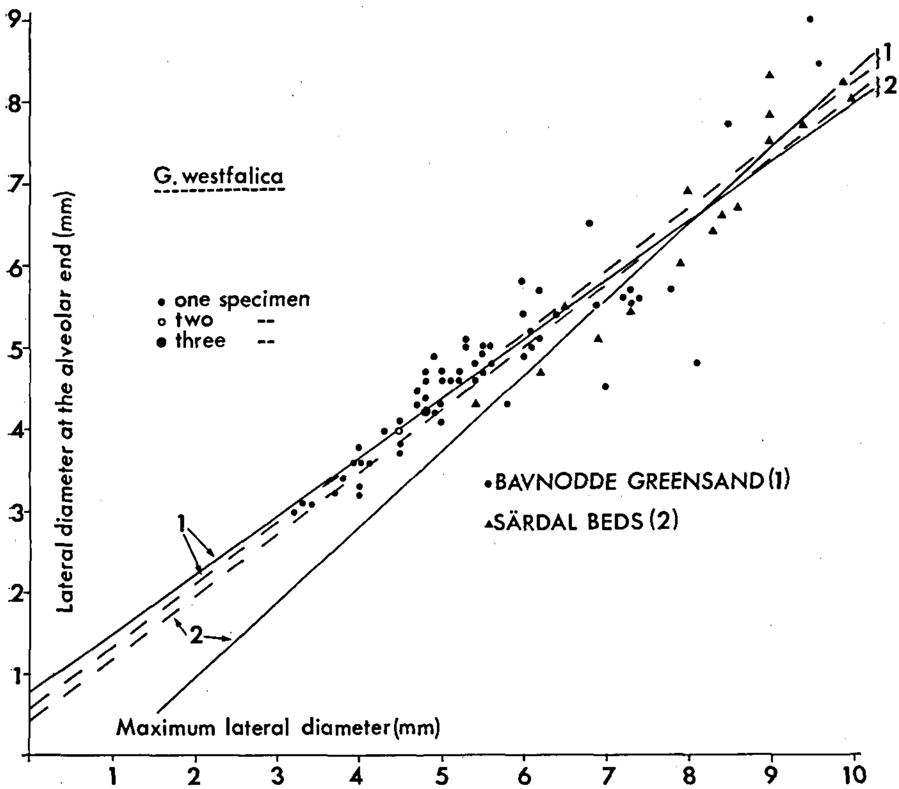


Fig. 9. Scatterdiagram and growth curves for *G. westfalica westfalica* from the Särdal beds and the Bavnodde Greensand.

Maximum lateral diameter (x) versus lateral diameter at the alveolar end (y): The scatterdiagram of the two samples is shown in fig. 9. The equations of the growth curves are given below:

the Särdal beds:
$y = -0.9109 + 0.9220x$; $r = 0.9541$; $N = 16$; $SD_{yx} = 0.4014$;

the Bavnodde Greensand:
$y = 0.7699 + 0.7246x$; $r = 0.9041$; $N = 64$; $SD_{yx} = 0.4834$;

The correlation coefficient of the two samples are highly significant ($P > 0.1\ \%$).

The growth curves can be considered as estimates of the same theoretical growth curve as no differences in the variances, the slopes, and the positions could be shown. The equations for the parallel growth curves are:

the Särdal beds: $y = 0.4035 + 0.7600x$;

the Bavnodde Greensand: $y = 0.5774 + 0.7600x$;

A t-test on the y-intercept for the sample from the Bavnodde Greensand gave $t = 3.1489$ with 62 degrees of freedom, which is highly significant ($0.5\ \% > P > 0.1\ \%$). This indicates an allometric relationship. In the sample from the Särdal beds the t-test showed that the intercept on the y-axis did not differ significantly from zero, and this implies that the relationship between the variates can be considered as isometric. This corresponds to the previous case and may be explained in the same way.

Summarising remarks: A statistically significant difference in the mean length of the guard of the samples from the Särdal beds and the Bavnodde Greensand has been shown. Minor differences in the variances of the growth curves "length of the guard—depth of the pseudoalveolus" and "length of the guard—dorso-ventral diameter at the alveolar end" were also noted. In the first case the sample from the Bavnodde Greensand had the larger variance, while in the second case the variance of the sample from the Särdal beds was the larger. This may well be explained by the small number of specimens in the sample from the Särdal beds.

As a difference in size seems to be of little taxonomic value, it can be concluded that it is not possible to distinguish the two samples of *G. westfalica westfalica* from the Bavnodde Greensand and the Särdal beds by the investigated characters.

ERNST 1968			Belemnite zones		Echinoderm zones	Inoceramus zones	STOLLEY 1930	
LOWER CAMPANIAN	lower	pilula Zone	G. quadrata quadrata	RQ = c. 4.0	Offaster pilula		unteres	QUADRATEN-SENON
		lingua/quadrata Zone		RQ = 4.0 - 5.0				
		granulataquadrata Zone	G. granulataquadrata	RQ = 5.0 - 6.0			oberes	GRANULATENSENON
UPPER SANTONIAN		Marsupites Zone	G. granulata	RQ = 6.0 - 7.0	Marsupites testudinarius		mittleres	
		Uintacrinus Zone	G. granulata	RQ = 7.0 - 8.0	Uintacrinus westfalicus	I. pinniformis		
MIDDLE SANTONIAN	upper	westfalicagranulata Zone	G. westfalicagranulata	RQ = 8.0 - 9.5			unteres	
	lower	cordiformis/westfalica Zone	G. westfalica	RQ = 9.5 - 11.5 / RQ > 11.5	Micraster coranguinum	I. cordiformis	obere	EMSCHER
LOWER SANTONIAN		undulatoplicatus Zone				I. undulatoplicatus		
UPPER CONIACIAN		subquadratus Zone				I. subquadratus	mittlere	
MIDDLE CONIACIAN		involutus Zone				I. involutus		

Table 6. Stratigraphical diagram, after Ernst (1968). RQ corresponds to the Riedel-Quotient and the figures are the mean values of the Riedel-Quotient of samples of *Gonioteuthis.*

Geographical distribution: *G. westfalica westfalica* has a widespread distribution in the Late Cretaceous Boral sea in northwestern Europe, and it is most common in northern Germany and southern Scandinavia.

Stratigraphical distribution: Schmid (1956) stated that *G. westfalica* has its first occurrence in the lower part of the *Inoceramus cordiformis* Zone. Birkelund (1957) showed that the species apparently also occurs in the uppermost part of the *Inoceramus undulatoplicatus* Zone. According to Jeletzky (1958, Vergleichtabelle) the species may occur in Russia in the *Inoceramus subquadratus* Zone and in the *Inoceramus involutus* Zone. Ernst (1966) stated that single specimens of *G. westfalica* may occur in the Coniacian and the lowermost part of the Lower Santonian, but that the main occurrence is in the upper part of the *I. undulatoplicatus* Zone and in the *I. cordiformis* Zone. According to Ernst (1964, 1968) it is possible to distinguish between samples of *G. westfalica* with a mean Riedel-Quotient above 11.5 from the upper part of the *I. undulatoplicatus* Zone and the lower part of the *I. cordiformis* Zone and samples of *G. westfalica* with a mean Riedel-Quotient of 9.5–11.5 from the upper part of the *cordiformis* Zone (cf. stratigraphical diagram on p. 130 in the present paper).

It should be noted that the relationship between the length of the guard and the depth of the pseudoalveolus of the two samples of *G. westfalica westfalica* from the Bavnodde Greensand and the Särdal beds can be considered as isometric (see p. 115), and it is therefore legal to compute the mean Riedel-Quotient. It should further be noted that a regression analysis of *G. westfalica westfalica* from Essen-Vogelheim based on Ernst's measurements placed at the author's disposal also showed an isometric relationship between the two characters.

Christensen (1971) showed, on the basis of the sample of *G. westfalica westfalica* from the Bavnodde Greensand with a mean Riedel-Quotient of 14.8, that the Bavnodde Greensand can be referred to the "lower *westfalica* beds". The sample of *G. westfalica westfalica* from the Särdal beds with a mean Riedel-Quotient of 16.9 can be referred to the same stratigraphical interval as the Bavnodde Greensand, viz. the uppermost part of the Lower Santonian and the lowermost part of the Middle Santonian.

Gonioteuthis lundgreni (Stolley, 1897)

Pl. 10, figs 6–9.

Material: 9 specimens, 2 of which are complete. Figured specimens MMH 12742–12745.

Short description: A *Gonioteuthis* with a mean length of about 60 mm; lanceolate in ventral view and slightly lanceolate, subcylindrical or highly conical in lateral view. The guard is markedly flattened ventrally. The Riedel-Quotient varies from about 6 to about 10. The cross-section of the pseudoalveolus at the alveolar end is subtriangular or pointed oval with the dorso-ventral diameter exceeding the lateral diameter in most specimens. The walls of the pseudoalveolus are straight or slightly curved and may carry conellae. The pseudoalveolus is often provided with dorsal and ventral notches, and a short ventral fissure may be present. The surface of a well preserved guard is characterised by a fine longitudinal striation and rather prominent vascular markings.

Remarks: Stolley (1897) erected *Actinocamax lundgreni* from the "Glass Marl" at Mulebyaa and *Actinocamax mammillatus* mut. *bornholmensis* from the Arnager Limestone. According to Ravn (1946) and Birkelund (1957) *A. lundgreni* and *A. bornholmensis* are conspecific and *A. bornholmensis* considered a junior synonym.

The age of the Arnager Limestone and the "Glass Marl" formerly has been the subject of much discussion, which is outlined in Birkelund (1957, pp. 17–18). Birkelund followed the views of Ravn (1918, 1946) and referred the two deposits to the Upper Turonian based on the presumed occurrence of *Scaphites geinitzi* D'Orbigny, *Inoceramus lamarcki* Parkinson var. *cuvieri* Sowerby, and *G. lundgreni*. However, Jeletzky (1958, p. 112) has indicated that the belemnites occurring in the Turonian were not so advanced as the belemnites occurring in the Arnager Limestone and the "Glass Marl". Douglas & Rankin (1969, p. 209), after a study on the planktic foraminifera from the upper third of the Arnager Limestone, concluded that this part of the formation was from the Coniacian or younger, but that the formation might span the stratigraphical interval from the Late Turonian to the Coniacian, or that the molluscs might be reworked.

However, *G. lundgreni* is used as an index fossil of the upper part of the Coniacian in Russia (Jeletzky, 1948a; Naidin, 1960, 1964, 1969). Consequently, *G. lundgreni* does not have to be interpreted as reworked from the Turonian. The state of preservation of the scaphitids and the inoceramids in the Arnager Limestone is very bad, and the value of the determination of these forms is therefore highly questionable. This can be demonstrated by reviewing the older determinations of the two fossil groups. Stolley (1897) stated that *I. lingua* Goldfuss and *S. inflatus* Römer were present in the Arnager Limestone. Ravn (1918) referred the inoceramids to *I. lamarcki* var. *cuvieri* and the scaphitids to *S. geinitzi*. Stolley (1930, p. 173) stated that the scaphitids cannot be referred with certainty to *S. geinitzi*, and he mentioned that Heinz had studied the inoceramids and referred them to *I. flaccidus*

White var. *gibbosa* Schlüter and *I. dankeri* Heinz. Ravn (1930) maintained that his determinations of *S. geinitzi* and *I. lamarcki* var. *cuvieri* were correct. It appears, therefore, highly probable that the Arnager Limestone and the "Glass Marl" are Coniacian in age.

Representatives of *G. lundgreni*, some of which are referred to other species, have also been reported from the early Santonian in the literature. Thus, Birkelund (1957) described *Actinocamax lundgreni excavata* (Sinzow) and *A.* aff. *westfalica* Schlüter from the greensand at Jydegaard and the Bavnodde Greensand. A study of this material has shown that *A.* aff. *westfalica* only differs from *A. lundgreni excavata* in being smaller in size. Ernst (1964) assigned three specimens from the "lower *westfalica* beds" in the Münster Basin to *Gonioteuthis lundgreni*/aff. *westfalica* sensu Birkelund. Casts of these three specimens have been studied and only two of the specimens (Ernst, 1964, pl. 3, figs 5 and 6) can be ascribed to *G. lundgreni*. Jeletzky (1949b, text-figs 1 and 2) figured two specimens of *G. lundgreni* from the early Santonian in the Saratow area in the eastern part of the Russian Platform as *Belemnitella propinqua* (Moberg).

Naidin (1964) referred the specimens of *G. lundgreni excavata* from Bornholm and the two specimens figured by Jeletzky to *Gonioteuthis (Goniocamax) lundgreni postexcavata* Naidin, and he restricted the two subspecies, *G. lundgreni lundgreni* and *G. lundgreni excavata*, to forms occurring in the Coniacian. *G. lundgreni excavata* was originally described from the *I. involutus* Zone (Middle Coniacian).

The specimens from the Särdal beds, which are identical to the forms from the early Santonian deposits in the Münster Basin and on Bornholm, are temporarily assigned to *G. lundgreni*. A detailed study planned by the author may show if it is possible to distinguish these forms from those occurring in the Coniacian.

Stratigraphical distribution: From the preceding discussion it follows that *G. lundgreni* has its first occurrence in the late Coniacian and continues into the early Santonian.

Geographical distribution: *G. lundgreni* has its main occurrence on the Russian Platform. Outside that area it can be found rarely in the northwestern part of the Late Cretaceous Boreal sea.

Actinocamax Miller, 1823
Actinocamax verus Miller, 1823

Pl. 10, fig. 10

Material: 7 specimens, 5 of which are complete. Figured specimen MMH 12746.

Short description: An *Actinocamax* with a small and stout guard, lanceolate in ventral and lateral view. The anterior end is provided with a low cone-shaped alveolar fracture, which is slightly asymmetrical as the dorsal side is a little more incised than the ventral side. The alveolar fracture is sharply demarcated from the surface of the guard. The anterior end is markedly compressed laterally.

Remarks: Naidin (1964) divided the small *Actinocamax* into two groups, viz. the *A. verus* group and the *A. laevigatus* group. The *A. laevigatus* group differs principally from the *A. verus* group in lacking granulation and in having in most cases a symmetrical alveolar fracture, which is not sharply demarcated from the surface of the guard. The *A. laevigatus* group has been found only in the "*Pteria*-beds" (lower Lower Campanian) from the Russian Platform.

The *A. verus* group has been studied especially by Russian palaeontologists, and for the time being the following "subspecies" are described: *A. verus verus* Miller, *A. verus fragilis* Arkhangelsky, *A. verus dnestrensis* Naidin, which are all known from western Europe and the Russian Platform; *A. verus subfragilis* Naidin, *A. verus antefragilis* Naidin, and *A. verus puschkariensis* Nikitin, which are only known from the Russian Platform.

A. verus verus, A verus fragilis, and *A. verus dnestrensis* differ in the development of the anterior end of the guard. *A. verus verus* has a low cone-shaped alveolar fracture, while *A. verus fragilis* has a high alveolar fracture which is up to one quarter of the entire length of the guard, and *A. verus dnestrensis* is provided with a shallow pseudoalveolus. These differences are due to a varied calcification of the anterior end of the guard, and therefore Birkelund (1957) did not distinguish between *A. verus verus* and *A. verus fragilis* as they occur together in the Bavnodde Greensand. *A. verus verus* and *A. verus dnestrensis* occur together in the uppermost Santonian and lowermost Campanian at Braunschweig (Müller & Wollemann, 1906; Ernst, 1968) and at Kullemölla in Sweden (Moberg, 1885; author's unpublished result).

It may be that quantitative studies on the *A. verus* group will show a gradual calcification of the anterior end of the guard from stratigraphically older to younger representatives, or that there may be a difference in the composition of the "subspecies" in samples of *A. verus* from different localities. Such studies must be made before the "subspecies" can be regarded as anything but variants and the classification of the Russian palaeontologists adopted in western Europe.

Stratigraphical distribution: *A. verus* occurs in northwestern Europe from the upper part of the *Inoceramus undulatoplicatus* Zone to the *Offaster pilula* Zone, and it is most frequent in the Upper Santonian (Ernst, 1963a, 1963b; Schmid, 1956). According to Naidin (1964) *A. verus fragilis* occurs on the Russian Platform from the Upper Turonian to the lower part of the Lower Campanian ("*Pteria*-beds"), *A. verus verus* from the Coniacian to the lower part of the Lower Campanian, and *A. verus dnestrensis* in the Santonian.

Actinocamax ex gr. *primus/plenus*

Pl. 11, figs 1–3

Material: 3 specimens, one of which is complete. Some of the undeterminable specimens, which exhibit the posterior part of the guard, possibly may belong to this group. Figured specimens MMH 12747–12749.

Short description: An *Actinocamax* with a long guard, lanceolate in ventral view and slightly lanceolate in lateral view. The guard is markedly flattened ventrally. The anterior end shows a low cone-shaped alveolar fracture with a small pit in its centre for the posterior part of the phragmocone (specimens 1 and 3), or a very shallow pseudoalveolus may be present (specimen 2). The alveolar fracture is demarcated sharply from the surface of the guard. The cross-section of the anterior end is subtriangular to pointed oval. A short ventral furrow is present in specimens 1 and 3, and specimen 1 is provided with a faint longitudinal striation on the ventral and lateral surfaces. The measurements in mm of the three specimens are given in table 7.

Specimens of *Actinocamax* ex gr. *primus/plenus*	Length of preserved part of the guard	Diameter at the alveolar end		Maximum diameter	
		dorso-ventrally	laterally	dorso-ventrally	laterally
No. 1 (MMH 12747)	51.0	4.4	-	-	-
No. 2 (MMH 12748)	37.0	8.1	7.7	10.3	11.3
No. 3 (MMH 12749)	38.5	7.7	7.2	8.8	9.6

Table 7.

Remarks: The dorsal side of the guard of specimen 1 is embedded in a very hard matrix and only the measurements of the length of the guard and the dorso-ventral diameter can be given. Furthermore, it is not known if this specimen possesses a sculpture on the dorsal surface. Specimens 2 and 3 show signs of heavy corrosion, which may have destroyed the surface sculpture.

According to Arkhangelsky (1912, p. 580) *Actinocamax primus* Arkhangelsky differs from *A. plenus* (Blainville) only in being longitudinally striated and in possessing single lateral furrows. Naidin (1964, p. 37), however, stated that both *A. primus* and *A. plenus* possess these two characters. The present author's study (unpublished) of *A. plenus* from Surrey in England and *A. primus* from Bornholm supports this view. According to Jeletzky (1948b, pp. 340–341) *A. primus* differs from *A. plenus* in being smaller and more slender; furthermore, Jeletzky stated that *A. primus* is not swollen posteriorly, and the apical point is central in *A. primus*. Birkelund (1957, p. 11) showed that in the specimens of *A. primus* from the Arnager Greensand on Bornholm the apex was slightly displaced towards the dorsal side.

Naidin (1964) split the species *A. plenus* into the following subspecies: *A. plenus plenus, A. plenus contractus, A. plenus crassus, A plenus triangulus, A plenus longus,* and *A. plenus actus.* Furthermore, Naidin (op. cit.) erected a new subspecies of *A. primus,* viz. *A. primus curtus.* The present author shares the view of Schmid (1965, p. 529) and Tröger (1968, p. 70) that additional work is required in order to test this classification in northwestern Europe.

Owing to the fragmentary condition of specimens 2 and 3 a definite specific determination is not possible, and specimen 1 might equally well be referred to *A. primus* as considered a juvenile guard of *A. plenus.* The three specimens are therefore referred to as *Actinocamax* ex gr. *primus/ plenus.*

Stratigraphical distribution: According to Jeletzky (1948b, pp. 341–343) *A. primus* occurs in the Middle Cenomanian and the lower part of the Upper Cenomanian, and is followed upwards by *A. plenus* in the upper part of the Upper Cenomanian and the Lower Turonian. Jeletzky's survey was based on the available knowledge on the stratigraphical distribution of the two species in England, France, Germany, Russia, and Czechoslovakia.

Recent investigations have shown that *A. plenus* in the Anglo-Paris Basin is confined to the "Plenus Marls" (Jefferies, 1963). The *A. plenus* Horizon was regarded by Jefferies (op. cit) as a subzone of the *Inoceramus labiatus* Zone (= the Lower Turonian). Hancock (in Jefferies, 1963, p. 31) recommended that the *A. plenus* Horizon be considered as a zone in its own right. The age of the *A. plenus* Zone has been the subject of much discussion, which is reviewed in Schmid (1965). The different opinions of the age of the *A. plenus* Zone are due partly to the fact that there appears to be a gap, corresponding to the *A. plenus* Zone, between the type Cenomanian and the type Turonian (Jefferies, 1963, p. 24; Sigal, 1959, p. 860). Therefore, the *A. plenus* Zone in Bohemia and Saxony is referred by Tröger (1968, 1969) to the passage beds between the Upper Cenomanian and the Lower Turonian. According to Tröger (1968, p. 7) *A. plenus* has never been found together with *Inoceramus labiatus* in Bohemia and Saxony. The single specimen of *A. plenus* from the "Rotpläner" in Niedersachsen discussed by Schmid (1965) was found in the stratigraphical interval between the "Arme *rhotomagense*-Schichten" of Late Cenomanian age and the first occurrence of *I. labiatus*.

A. primus starts in England in the Middle Cenomanian (W. J. Kennedy, personal communication, 1970) and continues into the "Plenus Marls" (Hancock, 1958; personal communication, 1970).

Geographical distribution: *A. plenus* has a widespread distribution in northwestern Europe. Furthermore, Naidin (1964) reported that *A. plenus plenus* also had been found in the Transcaspian area (the Mangyshlak peninsula) outside the Russian Platform, whereas the specimens of *A. plenus* found on the Russian Platform belong to the other subspecies.

A. primus has been reported from England, Northern Ireland, southern Scandinavia, and the Russian Platform. In addition Birkelund (1956) reported *A.* cf. *primus* from western Greenland.

Actinocamax? sp. indet.

pl. 11, figs 4–5

Three fragments of the middle part of the guard of some rather large belemnites (MMH 12750–12751) have been found in the derived phosphatised rock fragments. The specimens are characterised by possessing granules, which form corrugated transverse lines. Because the alveolar end is not preserved in these specimens a specific determination is not possible, but the specimens are very interesting, because large granulated belemnites are very seldom found in deposits of pre-Santonian age.

Actinocamax bohemicus Stolley, 1916 (figured in Fritsch & Schlönbach, 1872, pl. 16, fig. 17 as *B. strehlensis*) is according to the description by Fritsch & Schlönbach (op. cit. p. 19) characterised by having granules, which form corrugated transverse lines. The species was established on a single specimen from the Teplitzer Schichten in Bohemia, which is of Late Turonian age according to Tröger (1961). Naidin (1964, p. 142, footnote) reported that it is not possible to recognise granules on a plaster cast of *A. bohemicus.*

Actinocamax groenlandicus Birkelund, 1956 from the Lower Santonian (Birkelund, 1965) and *A.* aff. *groenlandicus* Birkelund, 1956 from the Upper Cretaceous in western Greenland also possess granules, but the granules are scattered and do not form corrugated transverse lines.

Actinocamax paderbornensis Schlüter, 1894 was based on a single unfigured fragment of the anterior end of a rather large guard from the Upper Turonian in the Münster Basin. According to Schlüter (1894, pp. 25–26) the specimen has " ... einzelne Granula-Artige Erhöhungen ..., welche etwa um den eigenen Durchmesser von einander entfernt stehen".

Actinocamax sternbergi was erected by Jeletzky (1961) on a single specimen from the Cretaceous Niobrara Chalk, and it is probably of late Coniacian or earliest Santonian age. The specimen has granules which do not form corrugated transverse lines.

The presence of granulation in the genus *Actinocamax* formerly was given great taxonomic significance. Birkelund (1956, p. 11), however, showed on the basis of *Actinocamax mammillatus ornatus* Moberg, 1885 (= ? *A. grossouvri ornatus*) from Kullemölla in Sweden that the granulation may be present within a species, which otherwise does not possess this character. Granulated specimens of the *A. primus/plenus* group from the late Cenomanian and the passage beds between the Cenomanian and the Turonian have not been recorded in the literature.

In view of the known variability of granulation in *Actinocamax* populations the present author is unwilling to ascribe part of the conglomerate at Särdal to the Upper Turonian or Coniacian based on the presence of only three granulated belemnite fragments. More belemnite material is necessary to solve this problem.

Stratigraphy and correlation

It is convenient here to sum up the vertical range in western Europe of the six belemnite species (cf. table 6).

B. propinqua propinqua—from the uppermost part of the Lower Santonian to the boundary between the lower and the upper part of the Middle Santonian.

G. westfalica westfalica—samples with a mean Riedel-Quotient above 11.5 characterise the stratigraphical interval from the uppermost part of the Lower Santonian to the lowermost part of the Middle Santonian.

G. lundgreni—from the late Coniacian to the early Santonian.

A. verus—from the uppermost part of the Lower Santonian to the middle Lower Campanian.

A. primus—from the Middle Cenomanian to the passage beds between the Cenomanian and the Turonian.

A. plenus—the passage beds between the Cenomanian and the Turonian.

Based on this outline it can be concluded that the limestone and the sandstone can be assigned to the boundary zone between the Lower and Middle Santonian, as can the Bavnodde Greensand (cf. also Christensen, 1971, p. 381). The three specimens of *Actinocamax* ex gr. *primus/plenus* from the derived phosphatised rock fragments indicate, however, that the locality was reached by the late Cretaceous sea already in the late Cenomanian or in the *A. plenus* Zone between the Cenomanian and the Turonian.

It is interesting to note that the same belemnite species occur in the limestone and sandstone at Särdal and in the Bavnodde Greensand, but that the composition is markedly different; especially the great number of specimens of *B. propinqua propinqua* from the Särdal beds should be stressed. This may be due to environmental conditions, as may also the differences in the mean length of the guard of *B. propinqua propinqua* and *G. westfalica westfalica* from the Särdal beds and the Bavnodde Greensand.

Plate 9

Fig. 1. *Belemnitella propinqua propinqua* (Moberg, 1885); MMH 12730. A: Dorsal view. B: Lateral view. C: View of the split anterior end showing the internal characters; X 3.

Fig. 2. *Belemnitella propinqua propinqua* (Moberg, 1885); MMH 12731. A: Dorsal view. B: View of the split anterior end showing the internal characters; X 3.

Fig. 3. *Belemnitella propinqua propinqua* (Moberg, 1885); MMH 12732. Dorsal view of a specimen with a rather obtuse posterior end.

Fig. 4. *Belemnitella propinqua propinqua* (Moberg, 1885); MMH 12733. A: Dorsal view. B: View of the split anterior end showing the internal characters; X 3. Complete specimen with a Riedel-Quotient of 3.53.

Fig. 5. *Belemnitella propinqua propinqua* (Moberg, 1885); MMH 12734. Dorsal view of a juvenile specimen.

Fig. 6. *Gonioteuthis westfalica westfalica* (Schlüter, 1874); MMH 12738. A: Dorsal view. B: Lateral view. C: Lateral view. D: Ventral view. E: View of the anterior end; X 2.

Fig. 7. *Gonioteuthis westfalica westfalica* (Schlüter, 1874); MMH 12739. A: Dorsal view. B: Lateral view.C: View of the anterior end; X 2. Specimen with a Riedel-Quotient of 13.6.

All figures natural size unless otherwise indicated. Photographed specimens are coated with ammonium chloride.

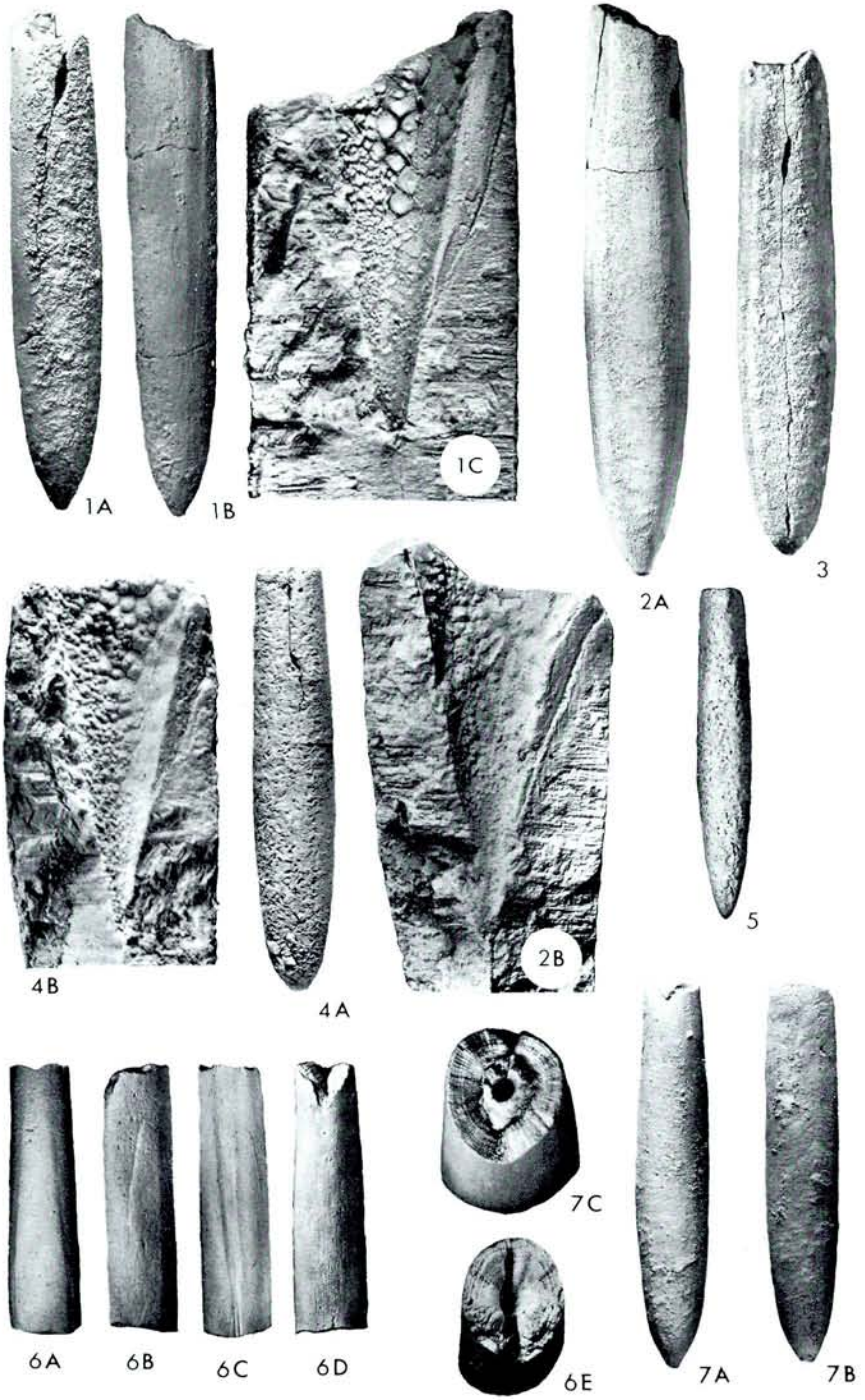

1A
1B
1C
2A
3
4B
4A
2B
5
6A
6B
6C
6D
7C
6E
7A
7B

Plate 10

Fig. 1–3. *Belemnitella propinqua propinqua* (Moberg, 1885). View of the split anterior end showing the internal characters; X 3. 1: MMH 12735. 2: MMH 12736. 3: MMH 12737.

Fig. 4. *Gonioteuthis westfalica westfalica* (Schlüter, 1874); MMH 12740. A: Dorsal view. B: View of the anterior end; X 2. Specimen with a low cone-shaped alveolar fracture; Riedel-Quotient of 20.1.

Fig. 5. *Gonioteuthis westfalica westfalica* (Schlüter, 1874); MMH 12741. Dorsal view of a specimen with a Riedel-Quotient of 13.1.

Fig. 6. *Gonioteuthis lundgreni* (Stolley, 1897); MMH 12742. A: Dorsal view. B: Lateral view. C: View of the anterior end; X 2. Specimen with a Riedel-Quotient of 8.1.

Fig. 7. *Gonioteuthis lundgreni* (Stolley, 1897); MMH 12743. View of the split anterior end showing the conellae; X 2.

Fig. 8. *Gonioteuthis lundgreni* (Stolley, 1897); MMH 12744. View of the anterior end; X 2.

Fig. 9. *Gonioteuthis lundgreni* (Stolley, 1897); MMH 12745. A: Dorsal view. B: View of the anterior end; X 2. Specimen with a Riedel-Quotient of 8.5.

Fig. 10. *Actinocamax verus* Miller, 1823; MMH 12746. Dorsal view.

All figures natural size unless otherwise indicated. Photographed specimens are coated with ammonium chloride.

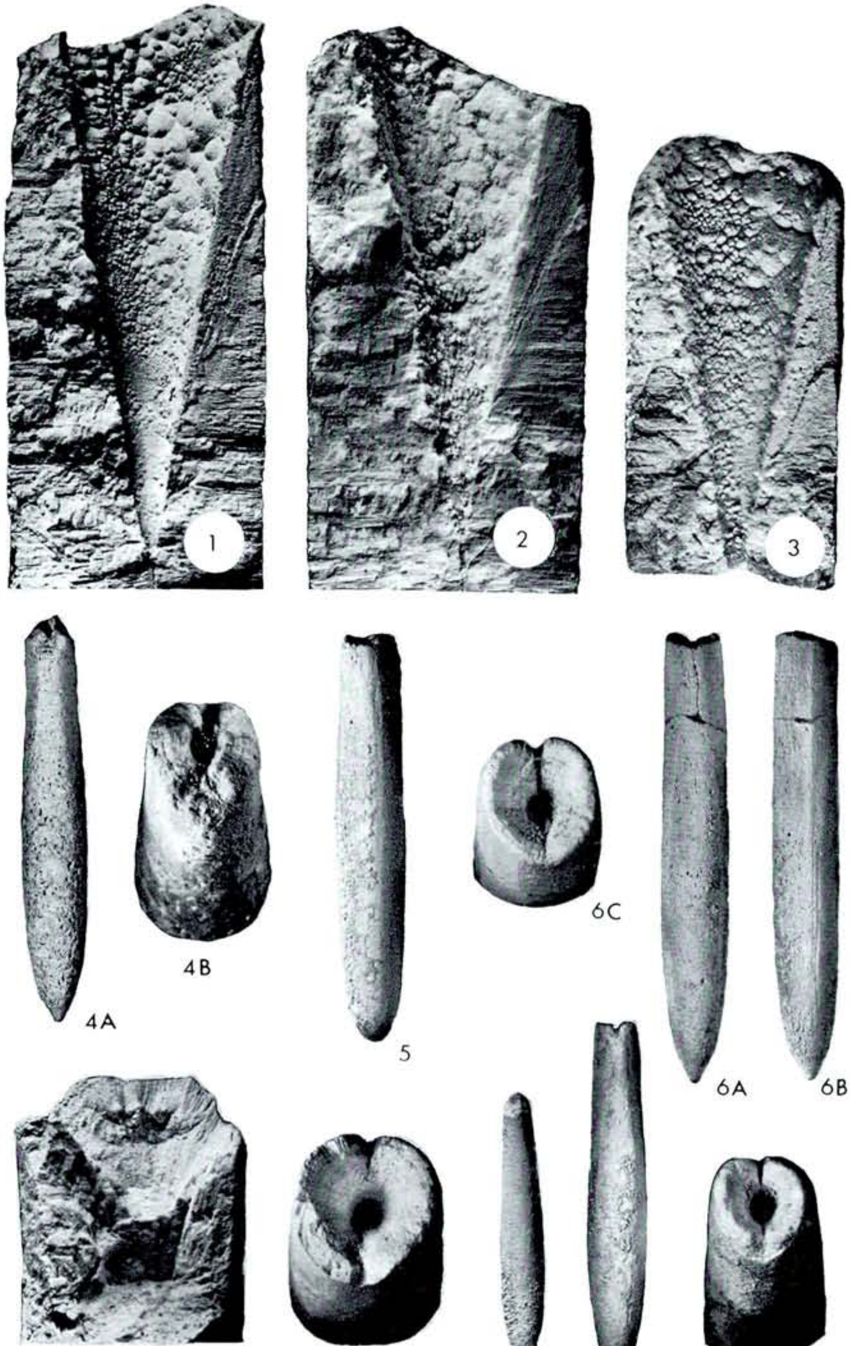

1
2
3
4A
4B
5
6A
6B
6C
7
8
9A
9B
10

Plate 11

Fig. 1. *Actinocamax* ex gr. *primus/plenus;* MMH 12749. A: Dorsal view. B: Lateral view. C: Ventral view. D: View of the anterior end; X 2.

Fig. 2. *Actinocamax* ex gr. *primus/plenus*; MMH 12748. A: Dorsal view. B: Lateral view, C: Ventral view. D: View of the anterior end; X 2.

Fig. 3. *Actinocamax* ex gr. *primus/plenus;* MMH 12747. A: Ventral view. B: View of the anterior end; X 5.

Fig. 4. *Actinocamax?* sp. indet.; MMH 12750. Dorsal view; X 2.

Fig. 5. *Actinocamax?* sp. indet.; MMH 12751. Dorsal view; X 2.

All figures natural size unless otherwise indicated. Photographed specimens are coated with ammonium chloride.


1A


1B


1C


1D

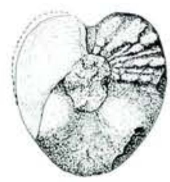

3A


2A

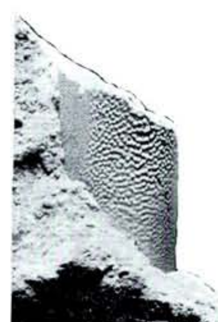

2B


2C


2D


3B


4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