Belemnitella from the lowermost Maastrichtian of Scania, southern Sweden

WALTER KEGEL CHRISTENSEN

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Reassessment of the basal Lower Maastrichtian *Belemnitella* assemblage from the Kristianstad Basin in Scania, southern Sweden has shown that it comprises *B. carlsbergensis* sp. nov. and *B.* aff. *B. mucronata*. These taxa co-occur with *Belemnella (Belemnella) lanceolata*, which accounts for about 90% of the belemnite fauna. Previous records of *B. mucronata* from the upper Upper Campanian and Lower Maastrichtian of Europe are shown to be misconceptions.

Key words: Belemnites, *Belemnitella calsbergensis* sp. nov., *Belemnitella* aff. *Belemnitella mucronata*, Upper Cretaceous, basal Lower Maastrichtian, Scania, southern Sweden.

W. K. Christensen [wkc@savik.geomus.ku.dk], Geological Museum, University of Copenhagen, Øster Voldgade 5–7, DK-1350 Copenhagen, Denmark. 26 January 1998.

In his monograph on the Upper Cretaceous belemnites from the Kristianstad Basin in Scania, southern Sweden, Christensen (1975) described a basal Lower Maastrichtian mixed *Belemnella/Belemnitella* assemblage from two abandoned pits at Balsvik and Bjärnum. The species were assigned to *Belemnella (Belemnella) lanceolata* (Schlotheim, 1813), *Belemnitella minor* Jeletzky, 1951 and *Belemnitella mucronata* (Schlotheim, 1813). The three species were recorded from Balsvik, where *B. (B.) lanceolata* accounts for about 90% of the belemnite fauna (Christensen 1997 b). Only two species, *B. (B.) lanceolata* and *B. minor*, were recorded from Bjärnum.

Christensen (1993: 49) mentioned that the determination of *Belemnitella minor* from Scania was in error, but that it was uncertain at that time to which species the *Belemnitella* samples should be assigned. Olszewska (1990) erroneously placed *B. minor* of Christensen (1975) in synonymy with *B. mucronata* (see discussions by Christensen 1993: 49, Christensen 1996: 756-757).

Christensen (1975) recorded two specimens of *B. mucronata* from Balsvik. Later, Christensen (1995: 48) discussed these and concluded that they most likely belong to *B. mucronata*, although the most complete specimen (MMH 13108) is closely comparable to *B. minor* subspecies II Christensen, 1995 in most of its critical characters. It has a smaller Schatzky distance, however.

Schulz (1979), in his monograph on the Lower Maastrichtian *Belemnella* Nowak, 1913 from northwest Europe, noted that the population of *Belemnella (Belemnella) lanceolata* from the Balsvik pit is more 'primitive' than other populations of this species studied by him. Consequently, he placed the population from Balsvik in the lower part of his new *Belemnella lanceolata* Zone, which is earliest Maastrichtian in age.

Christensen (1995) showed that the concept of *Belemnitella minor* based on its holotype (Sharpe 1853, Pl. 1: 2) was at variance with the concept based on its original diagnosis (Jeletzky 1951a, b). The latter concept was used by previous authors, whereas Christensen (1995) interpreted *B. minor* with respect to its holotype. In this respect *B. minor* is a very large species, which has a large Schatzky distance, a medium-sized fissure angle, and a small alveolar angle. Therefore, Christensen (1995) placed *B. minor* in the *B. mucronata* group, in contrast to Kongiel (1962), who placed it in the *B. langei* group, and Naidin (1979), who considered it as a subspecies of *B. langei*.

Two chronological subspecies of *B. minor* have been recognized: *B. minor* subspecies I, the nominotypical subspecies, from the lower part of the upper Upper

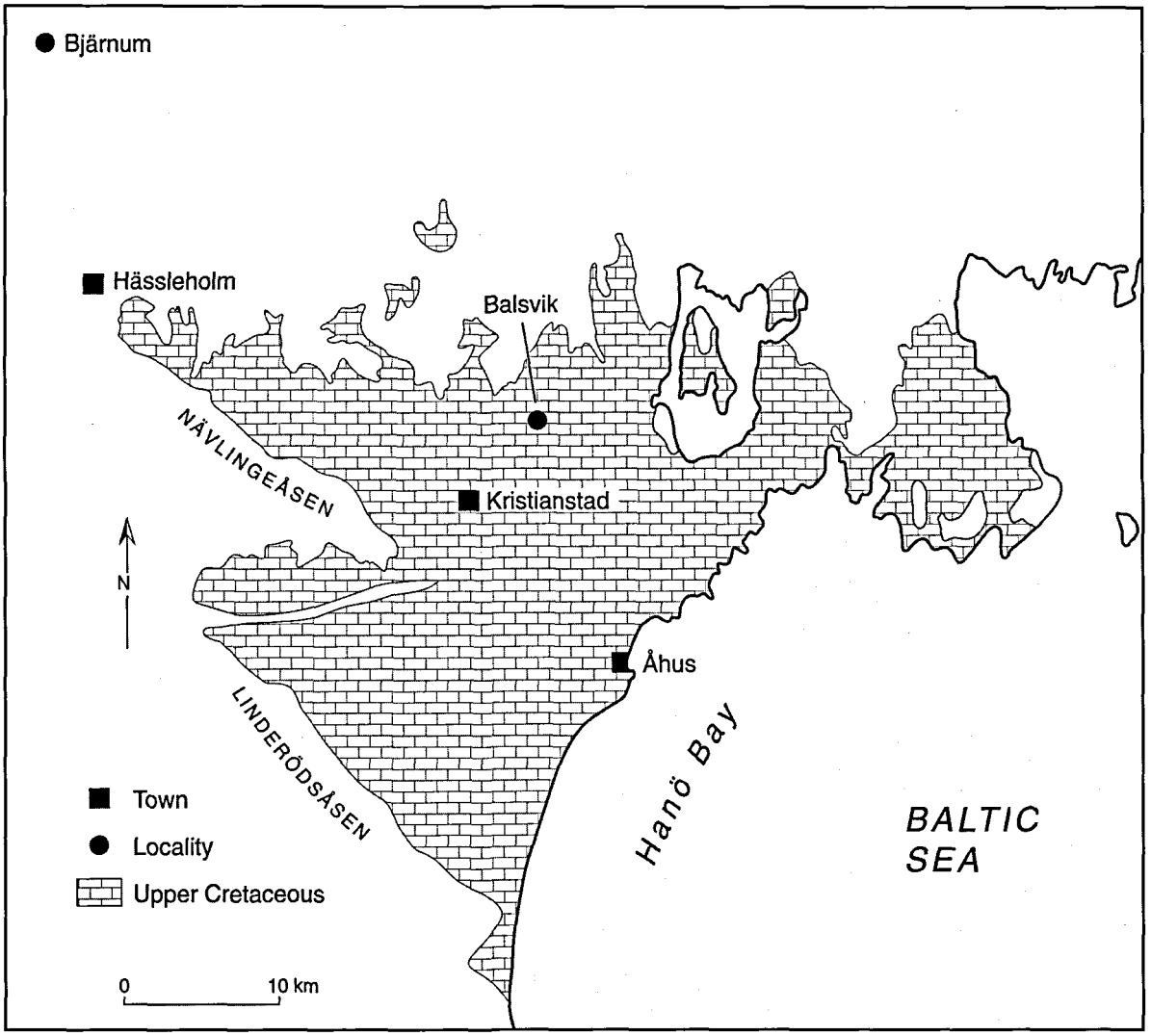


Fig. 1. Map of the Kristianstad Basin, showing the location of the abandoned pits at Balsvik and Bjärnum. Modified from Siverson (1992).

Campanian, and *B. minor* subspecies II Christensen, 1995, from the upper part of the upper Upper Campanian and lower Lower Maastrichtian. *B. minor* subspecies III Christensen, 1995 was placed in synonymy with *B. minor* II by Christensen (1997b, 1998).

B. minor I is closely comparable to *B. mucronata*, but differs in its larger and more slender guard, larger Schatzky distance, larger fissure angle, and smaller alveolar angle. *B. minor* II is closely similar to *B. minor* I, but is more stout and has a larger Schatzky distance. *B. minor* II differs from *B. mucronata* in its larger guard, larger Schatzky distance and smaller alveolar angle.

The aim of the present paper is to revise the basal Lower Maastrichtian *Belemnitella* assemblage of the Kristianstad Basin and discuss the stratigraphy of *B. mucronata*.

Geological setting

The Cretaceous Kristianstad Basin is bounded towards the southwest by the prominent Nävlingeåsen and Linderödsåsen horsts (Fig. 1). The sedimentary rock cover is limited towards the north by the thinning out of sediments and later erosion. Many outliers have been recorded north of the irregular denudational border of the continuous rock cover, including Bjärnum, which is one of the northernmost localities in the basin.

Basal Lower Maastrichtian *Belemnitella* d'Orbigny, 1840 from the Kristianstad Basin have been recorded from only two localities: the abandoned pits at Balsvik and Bjärnum (Fig. 1). These were discussed in detail by Christensen (1975) and are described below. The coordinates of the outcrops are given according to *Topografiska kartan över Sverige* (Topographical maps of Sweden), scale 1:50.000.

Balsvik (3E Karlshamn SV; VC 519157) (Fig. 2). – The belemnite fauna in the conglomerate at the bottom of the pit, and immediately below and above this unit, consists of common *Belemnellocamax balsvikensis* (Brotzen) and rare *Belemnitella mucronata*. This fauna is from the lowermost Upper Campanian.

The conglomerate is followed upwards by about 6 m of fine-grained calcarenite, the lower half of which is obscured by talus. The upper half has yielded *Belemnitella mucronata* and was assigned to the lower Upper Campanian.

A discontinuity surface with burrows terminates the Upper Campanian sequence and indicates an interruption of the sedimentation. The discontinuity surface is succeeded upwards by about 3 m of fine-grained calcarenite. Belemnites and the oyster *Pycnodonte vescicularis* are common at two horizons: 2–5 cm and 10–20 cm above the discontinuity surface, respectively. *Belemnella (Belemnella) lanceolata* predominates with subordinate *Belemnitella carlsbergensis* sp. nov. (rare) and *Belemnitella* aff. *mucronata* (very rare). This belemnite assemblage is from the basal Lower Maastrichtian, lower part of the *Belemnella lanceolata* Zone sensu Schulz (1979).

Bjärnum (3D Kristianstad NV; VC 396195). – This abandoned pit formerly exposed a 0.5 m thick conglomerate at its base, overlain by about 6 m of calcisiltite. The uppermost Lower Campanian *Belemnellocamax mammillatus* (Nilsson) occurs in the conglomerate. The calcisiltite has yielded a basal Lower Maastrichtian assemblage of *Belemnella (Belemnella) lanceolata* and *Belemnitella carlsbergensis* sp. nov., which belongs to the lower part of the *Belemnella lanceolata* Zone sensu Schulz (1979). Kennedy & Christensen (1997) recorded the Maastrichtian ammonite *Baculites knorrianus* (Desmarest) from this locality.

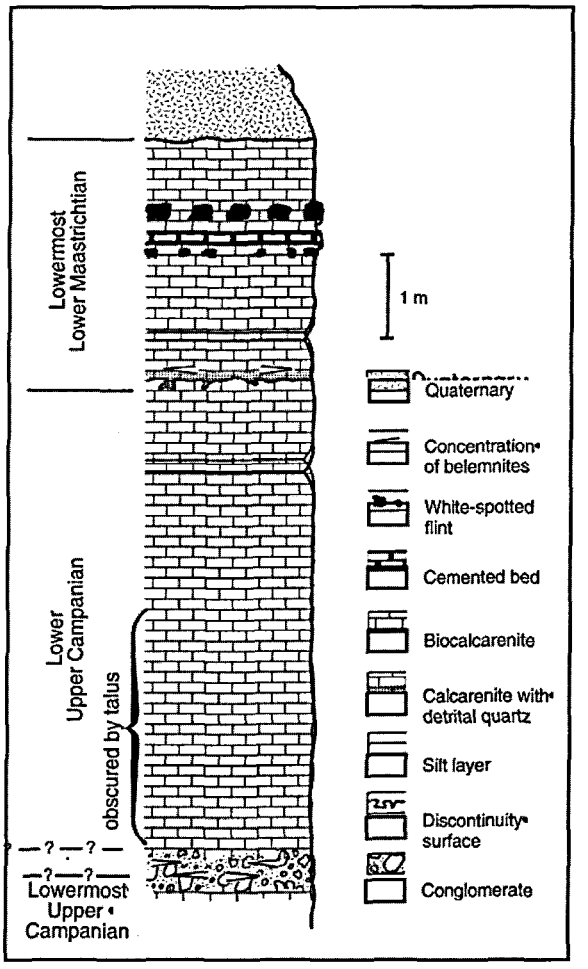


Fig. 2. Section of the abandoned pit at Balsvik. Modified from Christensen (1975).

Systematic Palaeontology

Terminology, measurements and biometric methods used below were discussed by Christensen (1975, 1986, 1991, 1995).

Figured specimens are housed in the Type Collection of the Geological Museum, University of Copenhagen, prefix MMH and MGUH.

Biometry. – Species variation is analyzed by univariate and bivariate biometric methods and is summarized by descriptive statistics, histograms and scatter diagrams.

Univariate analysis. – Estimates of the following statistics were calculated: arithmetical mean value ($\bar{X}$), standard deviation (SD), and coefficient of variation (CV). In addition, the observed range (OR) and number of specimens (N) are reported.

Bivariate analysis. – The regression line is written: $y = a + bx$, and the original measurements were used in the calculations, because of the linear trend on ordinary graph paper. Estimates of the following statistics were calculated: the slope (b), the standard deviation of the slope (SD_b), the intercept on the y-axis (a), the standard deviation of the intercept (SD_a), the standard deviation of the regression line (SD_{yx}), and the correlation coefficient (r). N is the number of specimens.

Family Belemnitellidae Pavlow, 1914
[ICZN 1985, Opinion 1328, name no. 572]

Genus *Belemnitella* d'Orbigny, 1840
[ICZN 1985, Opinion 1328, name no. 2269]

Type species. – *Belemnites mucronatus* Schlotheim, 1813, p. 111, by subsequent designation by Herrmannsen (1846: 105); ICZN Opinion (1985); name no. 2279.

Diagnosis. – See Christensen (1997a).

Remarks. – Christensen (1995) introduced a classification of size ranges of species of *Belemnitella* based on the length from the apex to the protoconch (LAP), which is as follows: 1) guard small, LAP less than 55 mm; 2) guard large, LAP 55–65 mm; and 3) guard very large, LAP larger than 65 mm. He also introduced a classification of the slenderness of the guard based on the mean Birkelund Index (BI) of Christensen (1995). This index is defined as the length from the apex to the protoconch divided by the dorso-ventral diameter at the protoconch. The classification is as follows: 1) guard stout, mean BI less than 4; 2) guard slender, mean BI from 4 to 5; and 3) guard very slender, mean BI larger than 5. These classifications are used herein.

Distribution. – *Belemnitella* appears at the base of the Santonian and continues to the top of the Maastrichtian. It is recorded from the North European and North American Provinces, as well as the northern margin of the Tethyan Realm in Europe (Christensen 1997a, b).

Belemnitella carlsbergensis sp. nov.
Pl. 1, figs 1-25

1975 *Belemnitella minor* Jeletzky – Christensen, p. 56, Pl. 11, figs 4-5
1993 *Belemnitella minor* sensu Christensen, p. 49
1995 *Belemnitella minor* sensu Christensen, p. 73
1996 *Belemnitella minor* Christensen – Christensen, p. 759
1997a *Belemnitella minor* Christensen – Christensen, p. 74
1997b *Belemnitella minor* Christensen – Christensen, p. 475

Derivation of name. – The species is named in honour of the Carlsberg Foundation, Copenhagen.

Holotype. – MMH 13112, Balsvik, basal Lower Maastrichtian, 2–20 cm above the discontinuity surface; Pl. 1, figs 19–22.

Measurements of the holotype. – Length from apex to protoconch, 55.6 mm; dorso-ventral diameter at protoconch, 13.6 mm; lateral diameter at protoconch, 12.9 mm; maximum lateral diameter, 13.2 mm; Schatzky distance, 7.0 mm; fissure angle 30.0°; alveolar angle, 20.0°; Birkelund Index, 4.1.

Plate 1
Belemnitella carlsbergensis sp. nov. from the basal Lower Maastrichtian of the Balsvik pit. Figured specimens are coated with ammonium chloride, except Figs 4, 8, 10, 14, 18, 22 and 25, and are natural size.

Figs 1–4. MGUH 24533, smallest specimen, with an average shape. 1, dorsal view; 2, lateral view, 3, ventral view; 4, view of the split anterior end, showing internal characters. Schatzky distance, 14.0 mm; fissure angle, 50.5°; alveolar angle, 19.0°; Birkelund Index, 4.1.

Figs 5–8. MGHU 24534, slender, adolescent specimen. 5, dorsal view; 6, lateral view; 7, ventral view; 8, view of the split guard, showing internal characters. Schatzky distance, 5.5 mm; fissure angle, *c.* 45°; alveolar angle not measurable; Birkelund Index, 5.0.

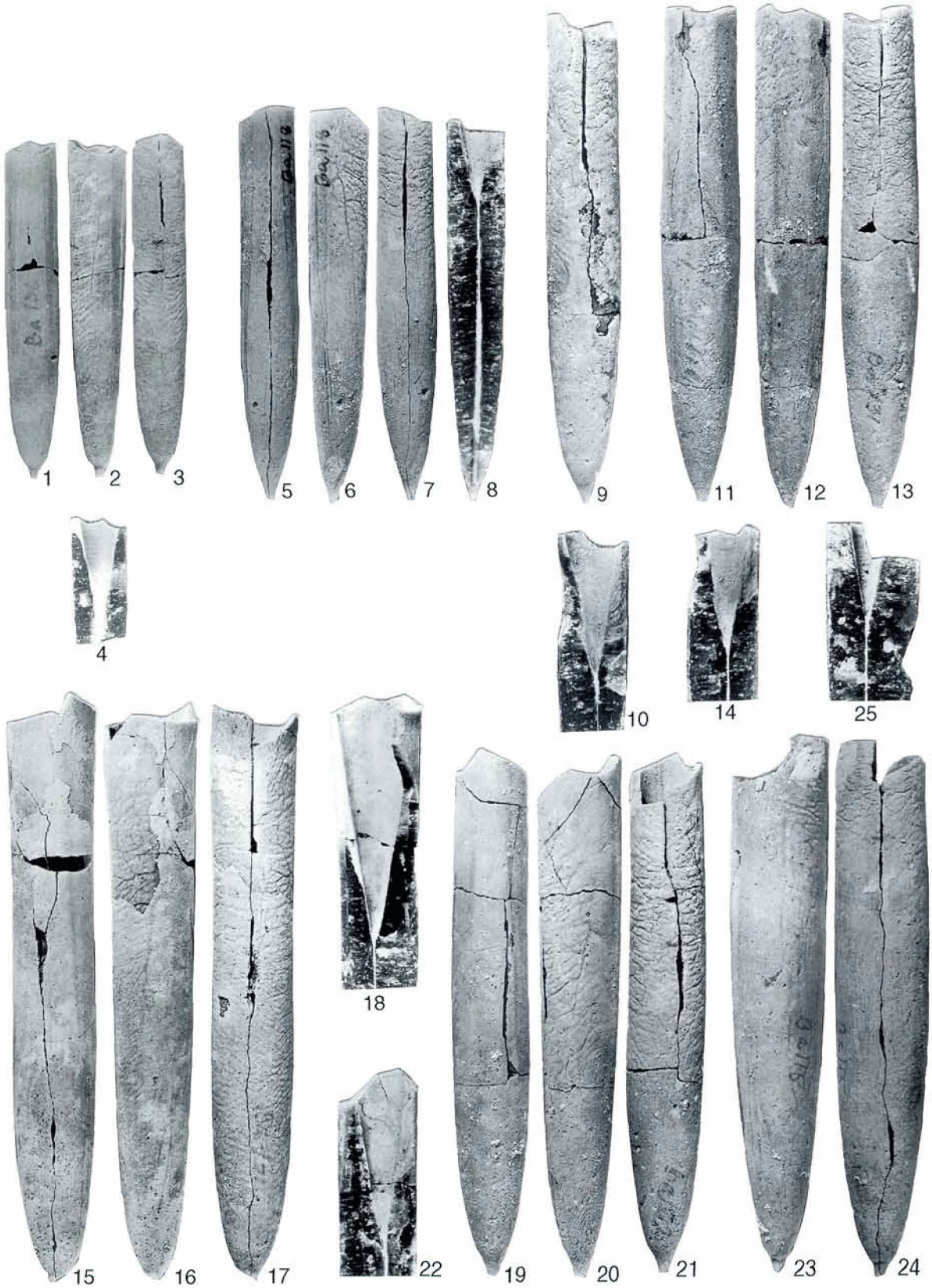
Figs 9–10. MGUH 24535, adult specimen with average shape. 9, ventral view; 10, view of split anterior end, showing internal characters. Schatzky distance, 5.4 mm; fissure angle, 65.0°; alveolar angle, 20.0°; Birkelund Index, 4.4.

Figs 11–14. MGUH 24536, slender, adult specimen. 11, dorsal view; 12, lateral view; 13, ventral view; 14, view of split anterior, showing internal characters. Schatzky distance, 6.1 mm; fissure angle, 43.0°; alveolar angle not measurable; Birkelund Index, 4.8.

Figs 15–18. MMH 13111, adult specimen, with an average shape. 15, dorsal view; 16, lateral view; 17, ventral view; 18, view of split anterior end, showing internal characters. Schatzky distance, 8.6 mm; fissure angle, 14.0°; alveolar angle, 19.5°; Birkelund Index, 4.0. Figured as *B. minor* by Christensen (1975, Pl. 11: 4).

Figs 19–22. MMH 13112, holotype. 19, dorsal view; 20, lateral view; 21, ventral view; 22, view of the split anterior end, showing internal characters. Schatzky distance, 7.0 mm; fissure angle, 30.0°; alveolar angle, 18.0°; Birkelund Index, 4.1. Figured as *B. minor* by Christensen (1975, Pl. 11: 5).

Figs 23–25. MGUH 24537, largest specimen, with an average shape. 23, lateral view; 24 ventral view; 25, view of the split anterior end, showing internal characters. Schatzky distance, 8.1 mm; fissure angle, 62.0°; alveolar angle not measurable; Birkelund Index, 4.4.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Material. – 43 specimens from the abandoned Balsvik pit and 29 specimens from the abandoned Bjärnum pit.

Diagnosis. – Guard very large and slender; apical end acute with a poorly delimited mucro; Schatzky distance medium-sized; fissure angle medium-sized; alveolar angle large; vascular markings fully developed ventrally and laterally, extending to apex.

Description. – Guard very large (length from apex to protoconch up to 71 mm) and slender, subcylindrical or slightly lanceolate in ventral view and high conical in lateral view; guard slightly or not flattened ventrally; dorso-ventral diameter at protoconch usually larger than lateral diameter; relationship of length from apex to protoconch and dorso-ventral diameter isometric, and mean value of Birkelund Index 4.2–4.3; Birkelund Index of individual specimens from about 3.5 to 5; apical end acute with a poorly delimited mucro.

Schatzky distance medium-sized (mean values from 7 to 8 mm), with an observed range from 5 to 14 mm; fissure angle medium-sized (mean values from 30° to 35°), but with a large observed range (13° to 82°); alveolar angle large (mean value about 20°), with an observed range from 18° to 21°. Shape of bottom of ventral fissure generally straight or straight with an outward bend distally.

Dorso-lateral depressions and double furrows fully developed; vascular markings conspicuous ventrally and laterally, and extending to apex; a few specimens with pseudogranulation ventrally, and longitudinal striae posteriorly.

Biometry. – Two samples were analyzed: 1) 30 specimens from Balsvik and 2) 16 specimens from Bjärnum. The sample from Balsvik consists of the specimens described by Christensen (1975), in addition to specimens collected subsequently. The sample from Bjärnum includes the specimens described by Christensen (1975). Univariate analyses were made for both samples; bivariate analysis only for sample 1 due to the small number of specimens in sample 2.

Table 1. Univariate analysis of *Belemnitella carlsbergensis* sp. nov. from the basal Lower Maastrichtian of the Balsvik pit. Abbreviations of characters: LAP = length from apex to protoconch, DVDP = dorso-ventral diameter at protoconch, LDP = lateral diameter at protoconch, MLD = maximum lateral diameter, SD = Schatzky distance, FA = fissure angle, AA = alveolar angle, BI = Birkelund Index. Measurements in mm and degrees.

Character	N	$\bar{X}$	SD	CV	OR
LAP	30	55.0	7.4	13.3	38.7–71.3
DVDP	30	13.0	1.9	14.3	9.2–16.2
LDP	26	12.6	2.1	16.3	9.1–15.7
MLD	25	12.8	2.1	16.1	9.3–16.3
SD	26	8.5	2.3	26.9	5.4–14.0
FA	24	33.7	18.4	54.6	13.0–82.0
AA	20	19.8	1.0	5.1	18.0–21.0
BI	29	4.3	0.4	8.2	3.5– 5.1

Table 2. Univariate analysis of *Belemnitella carlsbergensis* sp. nov. from the basal Lower Maastrichtian of the Bjärnum pit. Abbreviations of measured characters, see Table 1. Measurements in mm and degrees.

Character	N	$\bar{X}$	SD	CV	OR
LAP	9	56.2	5.1	9.0	49.4–62.9
DVDP	16	14.0	2.2	16.0	10.3–17.4
LDP	16	13.7	2.3	17.0	10.0–17.2
SD	15	7.0	1.2	17.8	5.0– 9.6
FA	13	29.7	11.4	38.4	15.0–53.5
AA	5	19.8	0.6	2.9	19.0–20.5
BI	9	4.2	0.4	9.7	3.7– 4.8

Univariate analysis. – The results of the two analyses are shown in Tables 1–2. Histograms of the length from the apex to the protoconch, Schatzky distance, fissure angle, alveolar angle and Birkelund Index of the sample from Balsvik are shown in Figure 3.

Bivariate analysis. – The scatter plot of the sample from Balsvik is shown in Figure 4, as is the regression line. The value of the correlation coefficient is

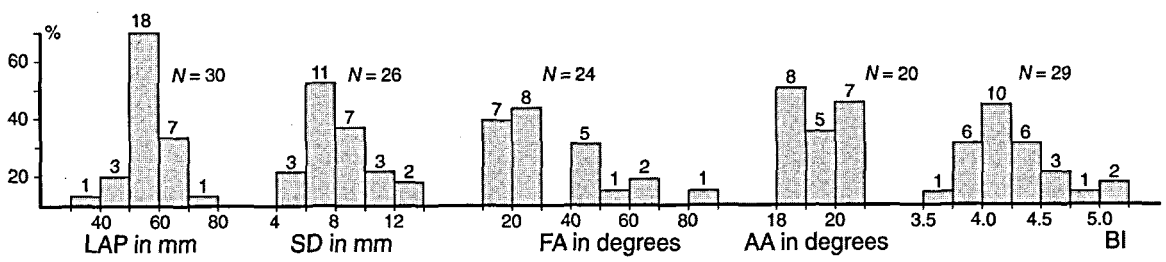

Fig. 3. Histograms of the length from the apex to the protoconch (LAP), Schatzky distance (SD), fissure angle (FA), alveolar angle (AA) and Birkelund Index (BI) of *Belemnitella carlsbergensis* sp. nov. from the basal Lower Maastrichtian of Balsvik. The figures above the bars are the actual number of specimens.

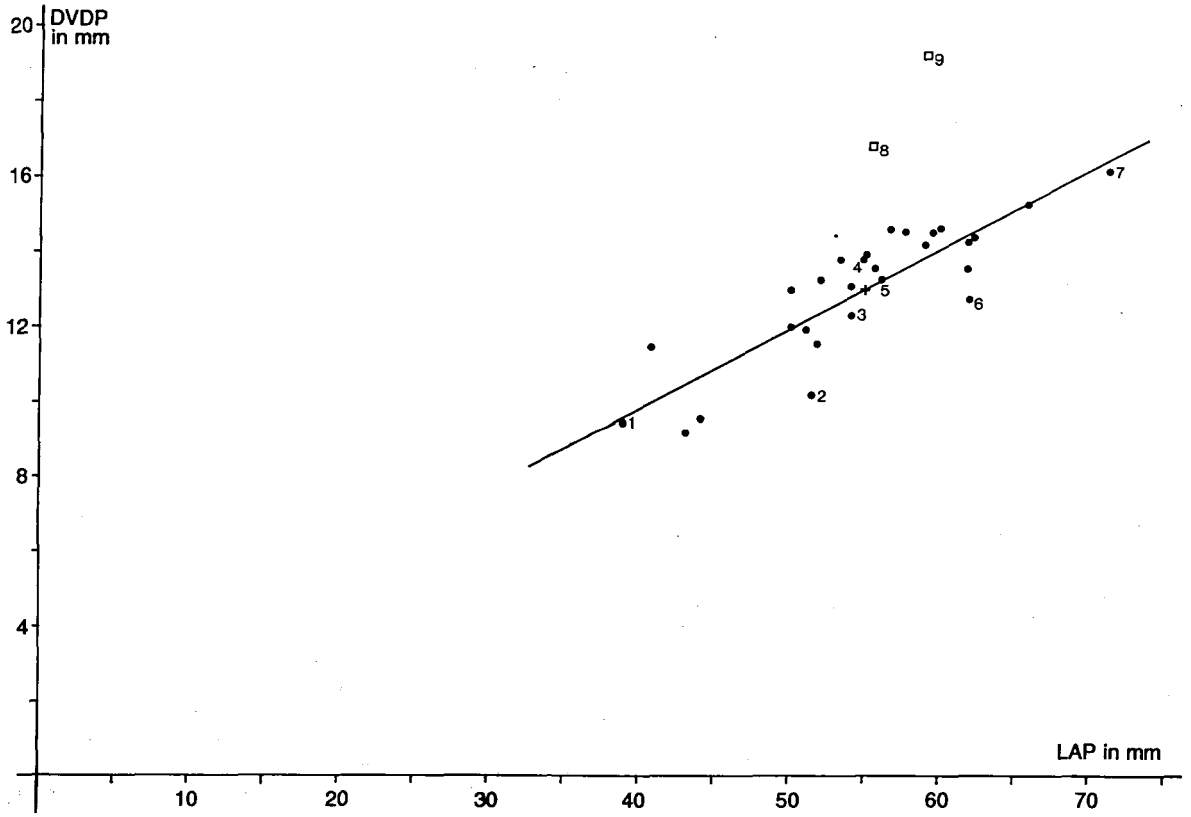

Fig. 4. Scatter plot and regression line for *Belemnitella carlsbergensis* sp. nov. from the basal Lower Maastrichtian of the Balsvik pit (dots). Two specimens of *Belemnitella* aff. *mucronata* are also plotted (open squares). LAP = length from apex to protoconch; DVDP = dorso-ventral diameter at protoconch; + = mean value. DVDP = 1.3510 + 0.2116LAP; N = 29; r = 0.8503; SD_a = 1.3555; SD_b = 0.0245; SD_{yx} = 0.9606. 1, MGUH 24533, Pl. 1: 1–4; 2, MGUH 24534, Pl. 1: 5–8; 3, MGUH 24535, Pl. 1: 9–10; 4, MMH 13111, Pl. 1: 15–18; 5, holotype, MMH 13112, Pl. 1: 19–22; 6, MGUH 24536, Pl. 1: 11–14; 7, MGUH 24537, Pl. 1: 23–25; 8, MMH 13108, Fig. 5A; 9, MGUH 24538, Fig. 5B.

very highly significant ($P < 0.001$, with 27 degrees of freedom). The t-test on the y-intercept shows that the intercept does not differ significantly from zero, implying an isometric relationship (t_a = 0.9967; 0.4 > P > 0.3, with 27 degrees of freedom).

Discussion. – *Belemnitella carlsbergensis* sp. nov. belongs to the uppermost Lower Campanian to Maastrichtian *B. mucronata* group of Christensen (1995), because it has a very large guard, a medium-sized Schatzky distance, a medium-sized fissure angle, and the shape of the bottom of the ventral fissure is usually straight or straight with an outward bend distally.

The affinity to species of the *B. mucronata* group, as well as other species (Table 3), is discussed below. *B. carlsbergensis* sp. nov. differs from the uppermost Lower and lower Upper Campanian *B. mucronata* in its larger and more slender guard and larger fissure angle; from the lower Upper Campanian *B. woodi* Christensen, 1995 by its larger, more slender and more vascularized guard, in additon to its larger fisssure angle and larger alveolar angle; from the lower Upper Campanian *B. minor* I in its larger alveolar angle; from the upper Upper Campanian and lower Lower Maastrichtian *B. minor* II in its more slender guard, smaller Schatzky distance and larger alveolar angle; from the upper Upper Campanian *B. pauli* Christensen, 1995 in its larger guard and smaller fissure angle; from the middle Upper Campanian *B.* aff. *langei* Christensen 1986 in its larger guard, larger fissure angle, and its shape in ventral view; from the upper Lower Maastrichtian *B.* ex gr. *junior* Nowak, 1913 of Keutgen & van der Tuuk, 1990 in its larger guard, larger fissure angle and larger alveolar angle; and from the Upper Maastrichtian *B. junior* in its more stout guard and larger alveolar angle.

It differs from the upper Upper Campanian *B. hoeferi* (Schloenbach, 1867) in its larger guard and larger fissure angle. This previous poorly known species from

Table 3. Key measurements of 12 species of the uppermost Lower Campanian-Maastrichtian *Belemnitella mucronata* group, as well as other species. The mean values of the Birkelund Index (BI), Schatzky distance (SD), fissure angle (FA) and alveolar angle (AA) are based on representative samples or on weighted grand means of several samples. Sources: Christensen (1995, 1998, unpublished).

Species	Max. LAP in mm	$\overline{X}_{BI}$	$\overline{X}_{SD}$ in mm	$\overline{X}_{FA}$ in degrees	$\overline{X}_{AA}$ in degrees
B. mucronata	<65	3.3–3.6	7–9	15–25	20–21
B. woodi	*c.* 55	3.3–3.4	*c.* 9	25–30	*c.* 19
B. minor I	70	*c.* 4	9–10	*c.* 30	*c.* 19
B. minor II	70	3.5–3.6	11–12	*c.* 30	*c.* 19
B. pauli	60	3.9	*c.* 7	*c.* 70	*c.* 20
B. aff. *langei*	*c.* 55	4.4–4.6	*c.* 7	*c.* 17	*c.* 20
B. ex gr. *junior*	65	*c.* 4	*c.* 7	*c.* 26	18.5
B. junior	75	4.6	*c.* 8	*c.* 30	19
B. hoeferi	60	4.4	*c.* 9	17	20.5
B. langei sensu Schulz	<65	*c.* 5	*c.* 6	40.0	17
B. cf. *najdini* sensu Schulz	<60	*c.* 4	8	56	*c.* 19
B. langei sensu Birkelund	<55	*c.* 4	*c.* 8	*c.* 50	*c.* 21

Austria has recently been fully described by Christensen (1998).

Three poorly known species occur in the European upper Upper Campanian and basal Lower Maastrichtian: the upper Upper Campanian *B. langei* sensu Schulz (1978), the uppermost Upper Campanian *B.* cf. *najdini* sensu Schulz (1978), and the basal Lower Maastrichtian *B. langei* sensu Birkelund (1957). Christensen (1995: Tables on pages 70, 72, 78) analyzed biometrically very small samples of these taxa. *B. carlsbergensis* sp. nov. differs from *B. langei* sensu Schulz in its larger and more stout guard, larger Schatzky distance, smaller fissure angle and larger alveolar angle; from *B.* cf. *najdini* sensu Schulz in its larger guard, smaller fissure angle and larger alveolar angle; and from *B. langei* sensu Birkelund in its larger

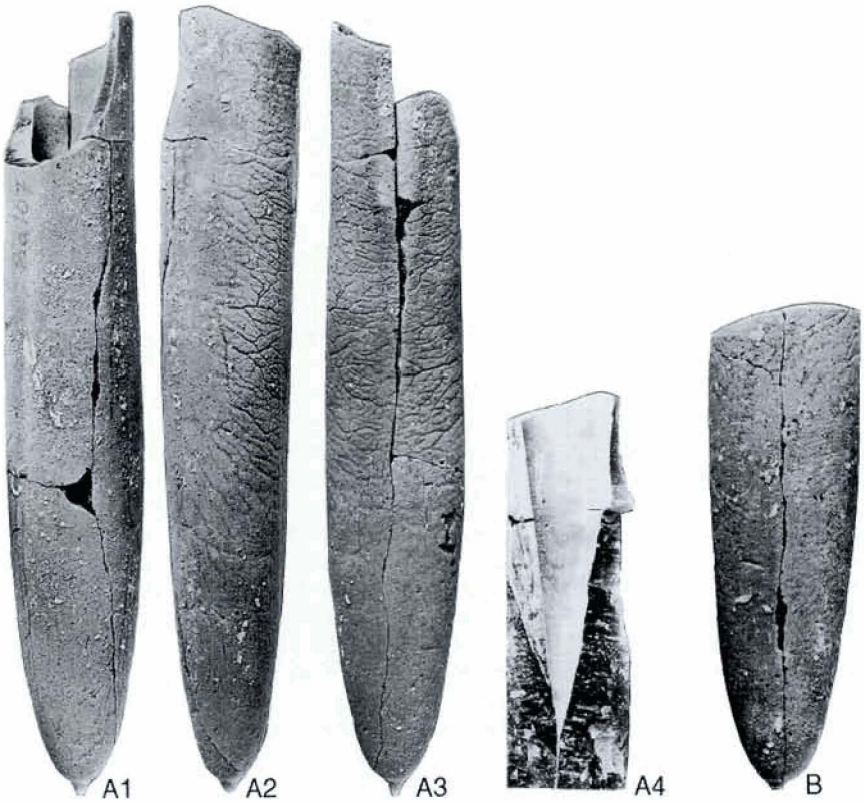

Fig. 5. *Belemnitella* aff. *Belemnitella mucronata* from the basal Lower Maastrichtian of the Balsvik pit. Specimens are coated with ammonium chloride, except A4, and are natural size. *A*, MMH 13108. 1, dorsal view; 2, lateral view; 3, ventral view; 4 view of the split anterior end showing internal characters. Figured as *B. mucronata* by Christensen (1975, Pl. 11: 1). *B*, MGUH 24538, apical fragment in ventral view.

guard, smaller fissure angle and smaller alveolar angle.

Distribution. – *Belemnitella carlsbergensis* sp. nov. is known only from Balsvik and Bjärnum in the Kristianstad Basin in Scania, southern Sweden. It occurs there in the basal Lower Maastrichtian, lower part of the *Belemnella lanceolata* Zone of Schulz (1979).

Belemnitella aff. *Belemnitella mucronata* (Schlotheim, 1813)
Fig. 5
1975 *Belemnitella mucronata* (Link) – Christensen, p. 53, Pl. 11, fig. 1
1995 *Belemnitella mucronata* (Schlotheim) – Christensen, p. 48.
1997b *Belemnitella mucronata* (Schlotheim) – Christensen, p. 475

Material. – MMH 13108 and MGUH 24538 from the basal Lower Maastrichtian of the abandoned pit at Balsvik.

Dimensions. – See Table 4.

Description. – Guard large and stout, slightly lanceolate in ventral view, high conical in lateral view, and flattened ventrally; dorso-ventral diameter at protoconch smaller than lateral diameter at protoconch; apical end obtuse with a well-defined mucro, Birkelund Index 3.1–3.3; Schatzky distance (5.6 mm), fissure angle (15°) and alveolar angle (19°) small; shape of bottom of ventral fissure straight; guard strongly vascularized ventrally and laterally.

Discussion. – The internal characters are known in only one specimen, MMH 13108 (Table 4). With respect to both internal and external characters, MMH 13108 and MGUH 24538 differ in no significant respect from *B. mucronata*, although this species does not occur elsewhere in the Lower Maastrichtian (see discussion below). The two specimens are also closely comparable to the uppermost Campanian and lower Lower Maastrichtian *B. minor* II in most characters, that is in the size and shape of the guard, surface markings, fissure angle, and alveolar angle. However, MMH 13108 has a smaller Schatzky distance. I have analyzed three samples of *B. minor* II from the uppermost Upper Campanian and lower Lower Maastrichtian of Norfolk (Christensen 1995) and five samples from the lower Lower Maastrichtian of the Mons Basin (Christensen, unpublished), comprising a total of 75 specimens in which the Schatzky distance could be measured. None of these have a Schatzky distance of less than 7.6 mm. Since *B. mucronata* is not recorded elsewhere from the Maastrichtian and MMH 13108 has a smaller Schatzky distance than *B. minor* II, the two specimens from Balsvik are referred to *B.* aff. *B. mucronata*.

Table 4. Dimensions of *Belemnitella* aff. *Belemnitella mucronata* from the basal Lower Maastrichtian of the Balsvik pit. Abbreviations, see Table 1. Measurements in mm and degrees.

Character	MMH 13108	MGUH 24538
LAP	55.3	59.0
DVDP	16.9	19.3
LDP	18.3	20.4
MLD	18.6	–
SD	5.6	–
FA	15.0	–
AA	19.0	–
BI	3.3	3.1

B. aff. *B. mucronata* differs from *B. carlsbergensis* sp. nov. in its more stout guard (Fig. 4), which is markedly flattened ventrally. In addition, *B.* aff. *B. mucronata* has an obtuse apical end with a well-defined mucro.

Stratigraphy of *Belemnitella mucronata*

This species is used as an index fossil for the uppermost Lower and lower Upper Campanian. It has also been recorded from the upper Upper Campanian and Lower Maastrichtian of Poland (Kongiel 1962, Olszewska 1990) and the basal Lower Maastrichtian of England, Northern Ireland, northwest Germany and Scania (Christensen 1975). The record from Scania is discussed above.

Christensen (1995) suggested that the Polish upper Upper Campanian and Lower Maastrichtian specimens of *Belemnitella*, which were assigned to *B. mucronata* by Kongiel (1962), were most likely misidentified and probably should be placed in *B. minor* and *B.* ex gr. *junior* sensu Keutgen & van der Tuuk (1990). I studied subsequently four figured specimens (Kongiel 1962, Pl. 18: 1–12), which came from the upper Upper Campanian horizons 'r', 's' and 't'. These horizons equate with the upper part of the *Didymoceras donezianum* ammonite Zone and the *Nostoceras pozaryskii* ammonite Zone of Błaszkiewicz (1980). The uppermost Upper Campanian *N. pozaryskii* Zone was renamed the *N. hyatti* Zone by Kennedy et al. (1992), because *N. (N.) pozaryskii* Błaszkiewicz is a junior synonym of *N. (N.) hyatti* Stephenson. The four specimens assigned to *B. mucronata* by Kongiel (1962) are most likely *B. minor* II, because they fall within the variation of this species in most of their characters. However, the specimen figured on Pl. 18: 1–3 has a larger alveolar angle (22°) and the specimen figured on Pl. 18: 7–9 has a slightly smaller

Schatzky distance (6.5 mm) than *B. minor* II. These specimens may be extreme variants of *B. minor* II.

Lower Maastrichtian *Belemnitella mucronata*-like specimens from Norfolk, England were placed in *B. minor* III (= *B. minor* II, see above) by Christensen (1995).

Wood (1967) recorded, but did not describe, two species of *Belemnitella* from the lower Lower Maastrichtian of Northern Ireland. A large elongate *Belemnitella*, with an abnormally large Schatzky distance (commonly in excess of 12 mm), which was provisionally referred to *B.* aff. *junior*, and a corpulent *Belemnitella* with extensive vascularization of the ventral side of the guard, which was provisionally assigned to *B. posterior* Kongiel, 1962. Christensen (1995) placed *B.* aff. *junior* of Wood in synonymy with *B. minor* III (= *B. minor* II, see above).

B. posterior was placed in the *B. mucronata* group by Kongiel (1962), who recorded this species from the uppermost Upper Campanian and lower Lower Maastrichtian of Poland, that is from the upper part of the *Didymoceras donezianum* Zone to the *Belemnella lanceolata* Zone of Błaszkiewicz (1980). I recently studied the holotype and one of the paratypes of *B. posterior*. These are closely similar to *B. minor* II with respect to the size, shape and slenderness of the guard and vascular markings. The holotype (Kongiel 1962, Pl. 19: 7–9), from the uppermost Upper Campanian horizon 'r,' has a small Schatzky distance (6 mm), a large fissure angle (41°) and a large alveolar angle (21°). The paratype (Kongiel, Pl. 19: 1–3), from the lower Lower Maastrichtian horizon 'u', has a small Schatzky distance (7 mm), a large fissure angle (65°) and a large alveolar angle (23°). The fissure angles of both specimens are large, but fall within the variation of *B. minor* II. In contrast, the Schatzky distances of the holotype and paratype are smaller, and the alveolar angle of the paratype is larger than in *B. minor* II. Therefore, it is uncertain if the holotype and paratype are extreme variants of *B. minor* II or represent a separate species, which is characterized by its small Schatzky distance, large fissure angle and large alveolar angle.

Schulz (1982: 281) reported, but did not describe, three species of *Belemnitella* from the basal Lower Maastrichtian, lower half of the *Belemnella lanceolata* Zone, of the Kronsmoor pit in northwest Germany: *B. minor, B. najdini* Kongiel, 1962 and *B. posterior*. He placed these in the *B. mucronata* group. Christensen (1995), however, placed *B. najdini* in the *B. langei* group, because of its small and slender guard, small Schatzky distance, large fissure angle, and irregular bottom of the ventral fissure. This species is recorded only from the upper Upper Campanian elsewhere (Christensen 1995). Schulz (1978) recorded *B.* cf. *najdini* from the uppermost Upper Campanian *grimmensis-granulosus* Zone, except its uppermost part, of Kronsmoor. Thus, the record of *B. najdini* from the basal Lower Maastrichtian by Schulz (1982) is enigmatic. *B. posterior* is discussed above.

It can thus be concluded that *B. mucronata* does not occur in the upper Upper Campanian and Lower Maastrichtian of Europe, as previously suggested.

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Dansk sammendrag

En revision af slægten *Belemnitella* fra det nederste Nedre Maastrichtian i Kristianstad Bassinet i Skåne har vist, at der forekommer to arter, *B. carlsbergensis* n. sp. og *B.* aff. *mucronata*. Disse optræder sammem med *Belemnella (Belemnella) lanceolata*, som udgør ca. 90% af belemnitfaunaen. Den stratigrafiske udbredelse af *B. mucronata* diskuteres, og det vises, at denne art kun forekommer i det øverste Nedre Campanien og nedre Øvre Campanien.

References

Birkelund, T. 1957. Upper Cretaceous belemnites of Denmark. Biologiske Skrifter. Det Kongelige Danske Videnskabernes Selskab 9, 69 pp.

Błaszkiewicz, A. 1980. Campanian and Maastrichtian ammonites of the middle Vistula Valley, Poland: a stratigraphic-paleontological study. Prace Institutu Geologicznego 92, 63 pp.

Christensen, W. K. 1975. Upper Cretaceous belemnites from the Kristianstad area in Scania. Fossils and Strata 7, 69 pp.

Christensen, W. K. 1986. Upper Cretaceous belemnites from the Vomb Trough in Scania, Sweden. Sveriges Geologiska Undersökning Ca57, 57 pp.

Christensen, W. K. 1991. Belemnites from the Coniacian to Lower Campanian chalks of Norfolk and southern England. Palaeontology 34, 695–749.

Christensen, W. K. 1993. Upper Cretaceous belemnitellids from the Båstad Basin, southern Sweden. Geologiska Föreningens i Stockholm Förhandlingar 115, 39–57.

Christensen, W. K. 1995. *Belemnitella* from the Upper Campanian and Lower Maastrichtian chalk of Norfolk, England. Special Papers in Palaeontology 51, 84 pp.

Christensen, W. K. 1996. A review of the Upper Campanian and Maastrichtian belemmnite biostratigraphy of Europe. Cretaceous Research 17, 751–766.

Christensen, W. K. 1997a. The Late Cretaceous belemnite family Belemnitellidae: Taxonomy and evolutionary history. Bulletin of the Geological Society of Denmark 44, 59–88.

Christensen, W. K. 1997b. Palaeobiogeography and migration in the Late Cretaceous belemnite family Belemnitellidae. Acta Palaeontologica Polonica 42, 457–495.
Christensen, W. K. 1998. Upper Campanian *Belemnitella* from Austria. Beiträge zur Paläontologie 23, 13–21.
Herrmannsen, A. N. 1846. Indices Generum Malacozoorum. Primordia 1. 636 pp.
International Commission on Zoological Nomenclature 1985. Opinion 1328. *Belemnites mucronatus* Schlothein, 1813 (Coleoidea): Conserved and neotype designated. Bulletin of the Zoological Nomenclature 42, 222–225.
Jeletzky, J. A. 1951a. The place of the Trimingham and Norwich Chalk in the Campanian-Maestrichtian succession. Geological Magazine 88, 197–208.
Jeletzky, J. A. 1951b. Die Stratigraphie und Belemnitenfauna des Obercampan und Maastricht Westfalens, Nordwestdeutschlands und Dänemarks, sowie einige allgemeine Gliederungs-Probleme der jüngeren borealen Oberkreide Eurasiens. Beihefte Geologisches Jahrbuch 1, 142 pp.
Kennedy, W. K. & Christensen, W. K. 1997. Santonian to Maastrichtian ammonites from Scania, southern Sweden. Fossils and Strata 44, 75–128.
Kennedy, W. J., Cobban, W. A. & Scott, G. R. 1992. Ammonite correlation of the uppermost Campanian of Western Europe, the U.S. Golf Coast, Atlantic Seaboard and Western Interior, and the numerical age of the base of the Maastrichtian. Geological Magazine 129, 497–500.
Keutgen, N. & van der Tuuk, L. A. 1990. Belemnites from the Lower Maastrichtian of Limburg, Aachen and Liège. Mededelingen Rijks Geologische Dienst 44, 39 pp.
Kongiel, R. 1962. On belemnites from the Maastrichtian, Campanian and Santonian sediments in the Middle Vistula Valley (Central Poland). Prace Muzeum Ziemi 5, 148 pp.
Naidin, D. P. 1979. Vergleichende Stratigraphie der Oberen Kreide der Russischen Tafel und West-Europa. In Wiedmann, J. (ed.) Aspekte der Kreide Europas. International Union of Geological Sciences A6, 497–510.
Nowak, J. 1913. Untersuchungen über die Cephalopoden der oberen Kreide in Polen. III. Teil. Bulletin de l'Academie des Sciences de Cracovie. Classe des Sciences Mathématique et Naturelles. Série B. Sciences Naturelles, 1913, 335–415.
Olszewska, D. 1990. Belemnites from the Upper Cretaceous chalk of Mielnik (estern Poland). Acta Geologica Polonica 40, 111–128.
Orbigny, A. d' 1840–1842. Paléontologie française. Terrains Crétacés. 1. Céphalopodes. 1–120 (1840); 121–430 (1841); 431-662 (1842). Masson, Paris.
Pavlow, A. P. 1914. Jurassic and Lower Cretaceous Cephalopoda of northern Siberia. Zapiski Imperatorskoj Akademia Nauk 8, Po Fiziko-Matematičeskomu Otdeleniû 21, 68 pp. [In Russian].
Schloenbach, U. 1867. Ueber einen Belemniten aus der alpinen Kreide von Grünbach bei Wr.-Neustadt. Jahrbuch der Kaiserlich-Königlichen Geologischen Reichsanstalt 17, 589–593.
Schlotheim, E. F. von 1813. Beiträge zur Naturgeschichte der Versteinerungen in geognostischer Hinsicht. Leonhard's Taschenbuch für die gesammte Mineralogie mit Hinsicht auf die neuesten Entdeckungen 7, 134 pp.
Schulz, M.-G. 1978. Litho- und Biostratigraphie des Obercampan-Untermaastricht von Lägerdorf und Kronsmoor (SW-Holstein). Newsletters in Stratigraphy 7, 73–89.
Schulz, M.-G. 1979. Morphometrisch-variationsstatistische Untersuchungen zur Phylogenie der Belemniten-Gattung *Belemnella* im Untermaastricht NW-Europas. Geologisches Jahrbuch A47. 157 pp.
Schulz, M.-G. 1982. Erster Nachweis der Belemnitengattung *Belemnitella* (*B. pulchra* n. sp.) im mittleren Untermaastricht NW-Deutschlands. Geologisches Jahrbuch A61, 279–293.
Sharpe, D. 1853.Description of the fossil remains of Mollusca found in the Chalk of England. Part 1, Cephalopoda. Palaeontographical Society Monographs, 26 pp.
Siverson, M. 1992. Late Cretaceous *Paraorthacodus* (Palaeospinacidae, Neoselachii) from Sweden. Journal of Paleontology 66, 994–1001.
Wood, C. J. 1967. Some new observations on the Maestrichtian stage in the British Isles. Bulletin of the Geological Survey of Great Britain 27, 271–288.

Erratum

In the article by Christensen '*Belemnitella* from the lowermost Maastrichtian of Scania, southern Sweden' (*Bulletin of the Geological Society of Denmark* 45(1), pp. 11–21, 1998) Figure 2 on p. 13 was printed incorrectly outwith the author's control. The correct figure is reproduced below.

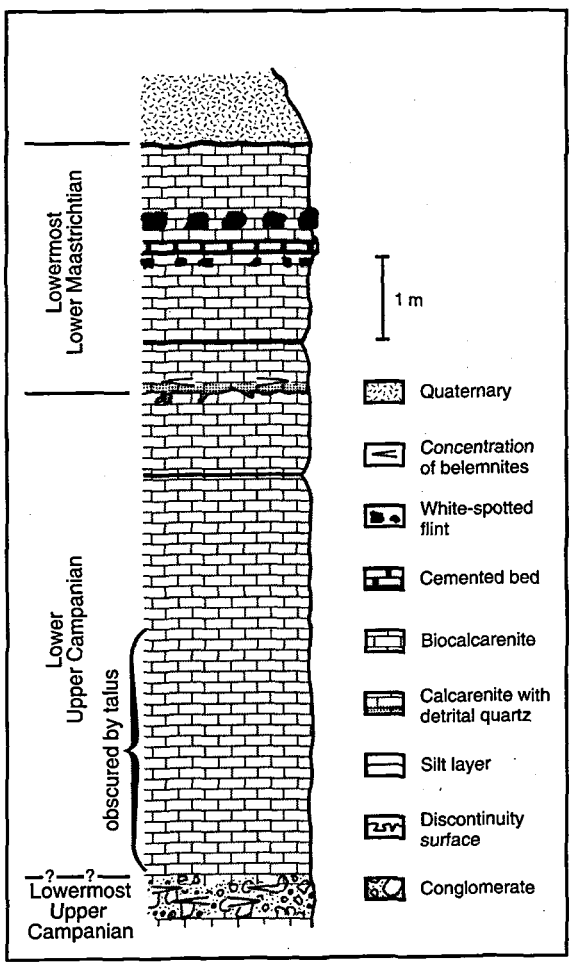

Fig. 2. Section of the abandoned pit at Balsvik. Modified from Christensen (1975).