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Upper Cretaceous belemnites from Lonzée (SE Belgium) and their stratigraphical significance

par Walter Kegel CHRISTENSEN

Abstract

The belemnitellid fauna of Lonzée consists of four, possibly five, species: *Actinocamax verus* MILLER, *Gonioteuthis westfalica westfalica* (SCHLÜTER), *G. westfalicagranulata* (STOLLEY), *G. granulata* (BLAINVILLE), and *G. granulataquadrata?* (STOLLEY). The minimum age of this fauna is Santonian, and the maximum age is Early Santonian to basal Early Campanian.

Key-words: Belemnitellids, *Actinocamax*, *Gonioteuthis*, Santonian, Lower Campanian?, Belgium.

Résumé

La faune de bélemnites récoltée à Lonzée comprend quatre, peut être cinq, espèces: *Actinocamax verus* MILLER, *Gonioteuthis westfalica westfalica* (SCHLÜTER), *G. westfalicagranulata* (STOLLEY), *G. granulata* (BLAINVILLE), and *G. granulataquadrata?* (STOLLEY). L'âge de cette faune est Santonien, mais pourrait inclure également le début du Campanien inférieur.

Mots-clefs: Bélemnites, *Actinocamax*, *Gonioteuthis*, Santonien, Campanien inférieur ?, Belgique.

Introduction

The Upper Cretaceous belemnitellids are of fundamental importance in biostratigraphy and correlation in the North European Province, because they were neritic animals occurring in a variety of near-shore and off-shore sedimentary facies, and their fossilization potential is great

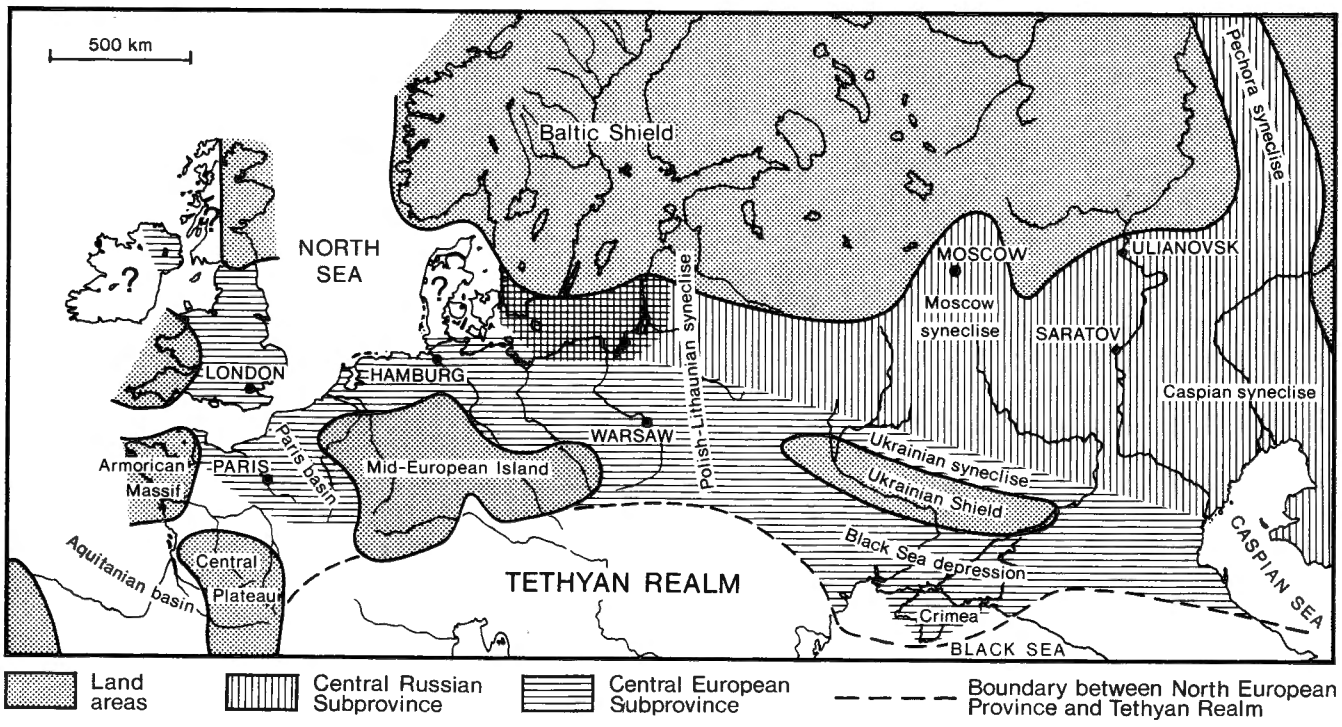

Fig. 1 — Distribution of Upper Cretaceous biogeographic units in Europe based on belemnites. Upper Cretaceous land and sea area represent maximum inundation for all stages. The boundaries are not reliable in detail, and the biogeographic units are typically gradational in characters. After CHRISTENSEN (1976).

BELEMNITES FROM LONZÉE	Argile inférieure	Argile supérieure	Without stratigraphic position	Number of specimens
Gonioteuthis spp.	3	60	95	158
Actinocamax verus	4	63	38	105
Number of specimens	7	123	133	263

Table 1 — Survey of the number of specimens of *Gonioteuthis* spp. and *Actinocamax verus* from Lonzée.

(CHRISTENSEN 1976, 1990). The North European Province extends from Ireland in the west to the Ural Mountains in the east and includes the Central European and Central Russian Subprovinces (Fig. 1). These subprovinces are well defined in the Middle Coniacian-Lower Campanian. The Central European Subprovince is characterized by the genus Gonioteuthis Bayle and the Central Russian Subprovince by the genus *Belemnitella* d'ORBIGNY (CHRISTENSEN 1975a, 1976, 1988, 1990, 1991).

The purpose of this paper is to describe the belemnite fauna of the Glauconie at Lonzée near Gembloux, SE Belgium. Lonzée is situated in the Central European Subprovince as defined by belemnites.

I have examined 263 belemnites from Lonzée (Table 1). About the half of the specimens are only labelled Lonzée. The remaining material, Collection IG 11039, was collected by M. Glibert in 1936, and he distinguished two levels: Argile inférieure and Argile supérieure.

All growth stages of *Gonioteuthis* spp. and *Actinocamax verus* are present at Lonzée indicating that the species lived and reproduced in that area.

Systematic Palaeontology

Family BELEMNITELLIDAE PAVLOW, 1914
Type genus: *Belemnitella* d'ORBIGNY, 1840.

DIAGNOSIS: See CHRISTENSEN (1975a).

DISTRIBUTION: Belemnitellidae are restricted to the Upper Cretaceous and are reported from the Lower Cenomanian to the Upper Maastrichtian. They are mainly distributed in the North Temperate Realm, which includes the North American and North European Provinces. A few representatives are also reported from the northern part of the Tethyan Realm.

Genus *Actinocamax* MILLER, 1823
Type species: *Actinocamax verus* MILLER, 1823 by original designation.

DIAGNOSIS: See CHRISTENSEN (1975a).

DISCUSSION: NAIDIN (1964) recognized three subgenera of *Actinocamax: A.* (*Actinocamax*), type species *A. verus* MILLER, 1823; *A.* (*Praeactinocamax*), type species *A. plenus* (BLAINVILLE, 1825); and *A.* (*Paractinocamax*), type species *A. grossouvrei* JANET, 1891. This classification was discussed by CHRISTENSEN (1982, 1986, 1991) and is not followed here. Species assigned to *A.* (*Paractinocamax*) by NAIDIN are placed in the genus *Belemnellocamax* NAIDIN. NAIDIN referred small species of *Actinocamax* to *A.* (*Actinocamax*) and large species of *Actinocamax* to *A.* (*Praeactinocamax*). Since the two subgenera only differ by their size, they were not recognized by CHRISTENSEN (1982, 1986, 1991). It has later been shown, however, that the growth is isometric in the small species *A. verus*, and allometric in the large species *A. primus* ARKHANGELSKY, 1912 and *A. plenus*, in addition to the medium sized species *Actinocamax cobbani* CHRISTENSEN, 1993 (see CHRISTENSEN, 1993).

DISTRIBUTION: *Actinocamax* is recorded from the North American and North European Provinces. It occurs from the Lower Cenomanian to the middle Lower Campanian.

Actinocamax verus MILLER, 1823
Pl. 1, Figs 1-3

* 1823 *Actinocamax verus* MILLER, p. 64, pl. 9, figs 17-18.
1912 *Actinocamax verus* var. *fragilis* ARKHANGELSKY, p. 597, pl. 9, figs 15-17.
1952 *Actinocamax verus* var. *dnestrensis* NAIDIN, p. 66, pl. 1, fig. 9; pl. 2, figs 1-2.
1991 *Actinocamax verus* Miller - CHRISTENSEN, p. 707, pl. 1, figs 1-9.

TYPE: The original of MILLER (1823, pl. 9, figs 17-18) was designated as lectotype by CHRISTENSEN (1991).

MATERIAL: Four specimens from the Argile inférieure; 63 specimens from the Argile supérieure; and 38 specimens from Lonzée without exact horizon.

DESCRIPTION: See CHRISTENSEN (1991).

DISCUSSION: NAIDIN (1964) recognized three subspecies of *A. verus* mainly on the basis of the structure of the alveolar end: *A. verus verus* has a low, cone-shaped

alveolar fracture, *A. verus fragilis* ARKHANGELSKY has a high, cone-shaped alveolar fracture, and *A. verus dnestrensis* NAIDIN has a very shallow pseudoalveolus. The subspecies were discussed by CHRISTENSEN (1986, 1991), who placed *A. verus dnestrensis* in synonymy with *A. v. verus* and suggested that *A. verus fragilis* may be a geographic subspecies prevailing on the Russian Platform.

The four specimens from the Argile inférieure have a low cone-shaped alveolar fracture (*verus*-like).

The 63 specimens from the Argile supérieure were analyzed with respect to the structure of the alveolar end:

verus-like specimens	22 (34.9%)
fragilis-like specimens	40 (63.5%)
dnestrensis-like specimens	1 (1.6%)

It is thus evident that *fragilis*-like specimens predominate in the Argile supérieure, although the sample shows a continuous series of forms ranging from *fragilis*-like

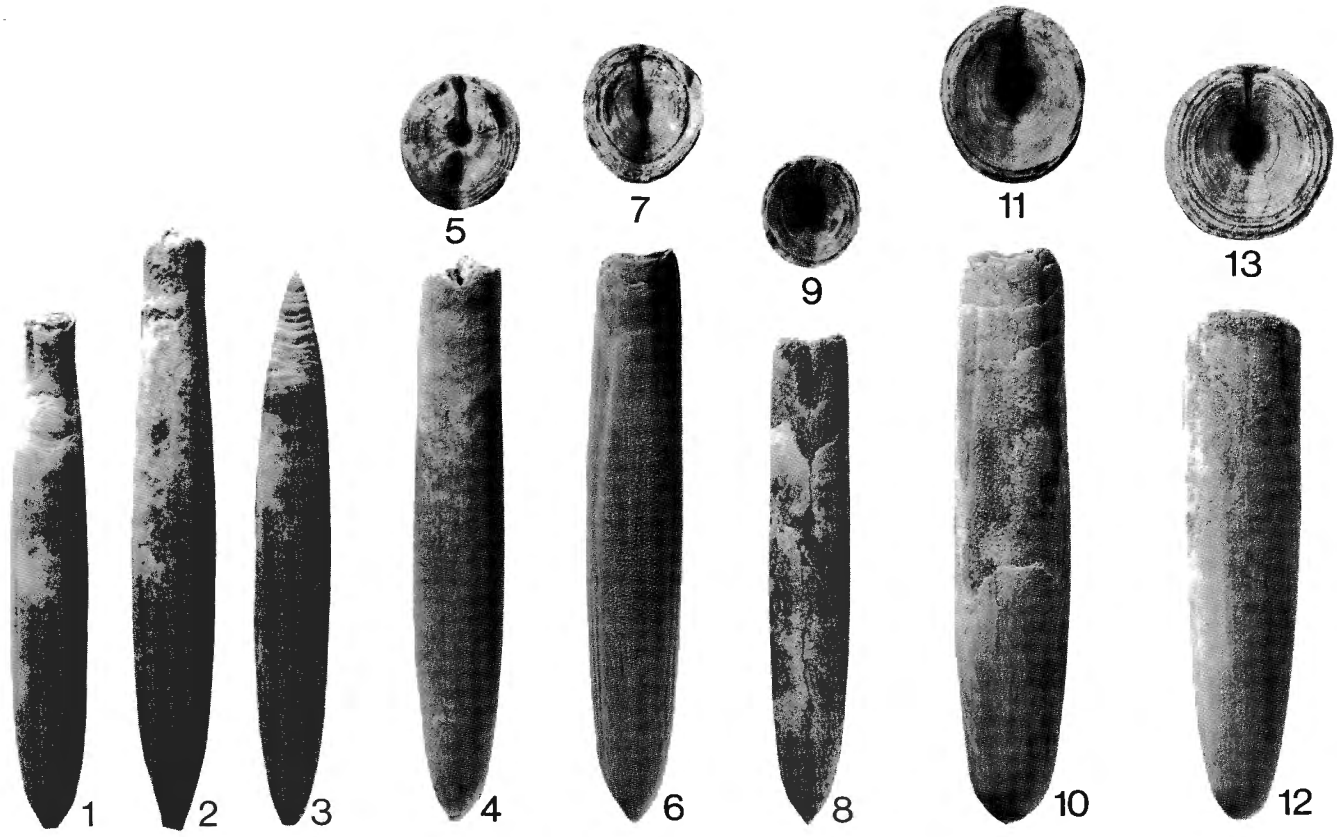

PLATE 1

Belemnitellids from the Argile supérieur, Lonzée. All specimens are coated with ammonium chloride, and are natural size unless otherwise stated.

Figs 1-3 — *Actinocamax verus* MILLER; 1, IRSNB MI 10622, specimen with a flat anterior end in dorsal view, X 1.5. 2, IRSNB IM 10623, specimen with a low cone- shaped alveolar fracture (verus-like) in ventral view, X 1.5. 3, IRSNB IM 10624, specimen with a high cone- shaped alveolar fracture (fragilis-like) in dorsal view, X 1.5.

Figs 4-5 — *Gonioteuthis westfalica westfalica* (SCHLÜTER), IRSNB IM 10625. 4, ventral view; 5, view of the anterior end; Riedel-Quotient, 18.9.

Figs 6-7 — *Gonioteuthis westfalica westfalica* (SCHLÜTER), IRSNB IM 10626. 6, dorsal view; 7, view of the anterior end; Riedel-Quotient, 10.8.

Figs 8-9 — *Gonioteuthis* sp., IRSNB IM 10627. 8, ventral view; 9, view of the anterior end; Riedel Quotient, 6.7.

Figs 10-11 — *Gonioteuthis granulataquadrata*? (STOLLEY), IRSNB IM 10628. 10, dorsal view; 11, view of the anterior end, X 1.5; Riedel Quotient, 5.4.

Figs 12-13 — *Gonioteuthis granulataquadrata*? (STOLLEY), IRSNB IM 10629. 12, dorsal view; 13, view of the anterior end, X 1.5; Riedel-Quotient, 5.1.

specimens, via *verus*-like specimens, to *dnestrensis*-like specimens. It is, however, astonishing that the sample is dominated by *fragilis*-like specimens, because samples of *A. verus* from the Santonian and Lower Campanian of NW Europe usually are dominated by *verus*-like specimens (CHRISTENSEN, 1991, p. 710). The suggestion by CHRISTENSEN (1986) that *A. verus fragilis* may be a geographic subspecies prevailing on the Russian Platform therefore cannot be upheld, and it is placed in synonymy with *A. verus*.

DISTRIBUTION: *A. verus* is widespread in the North European Province. In NW Europe it is recorded from the Lower Coniacian to the middle Lower Campanian; in offshore chalks it is most common in the Upper Santonian (CHRISTENSEN, 1991). On the Russian Platform it is recorded from the Turonian to the lower Lower Campanian (NAIDIN, 1964).

Genus *Gonioteuthis* BAYLE, 1878

Type species: *Belemnites quadratus* BLAINVILLE, 1827 by original designation.

DIAGNOSIS: See CHRISTENSEN (1975a).

REMARKS: The evolutionary lineage of *Gonioteuthis* includes seven species and subspecies occurring from the Middle Coniacian to the boundary between the Lower and Upper Campanian (Fig. 2). This lineage was studied by German authors, E. STOLLEY, G. ERNST, and M.-G. SCHULZ, in addition to I. JARVIS and W.K. CHRISTENSEN (see references in CHRISTENSEN 1975a,b, 1986, 1988, 1991). Eleven zones have been established on the basis of this lineage, and they were based mainly on the mean Riedel-Quotient, which is the length of the guard divided by the depth of the pseudoalveolus (ERNST 1964) (Fig. 2). The *Gonioteuthis* zonation was critically assessed by

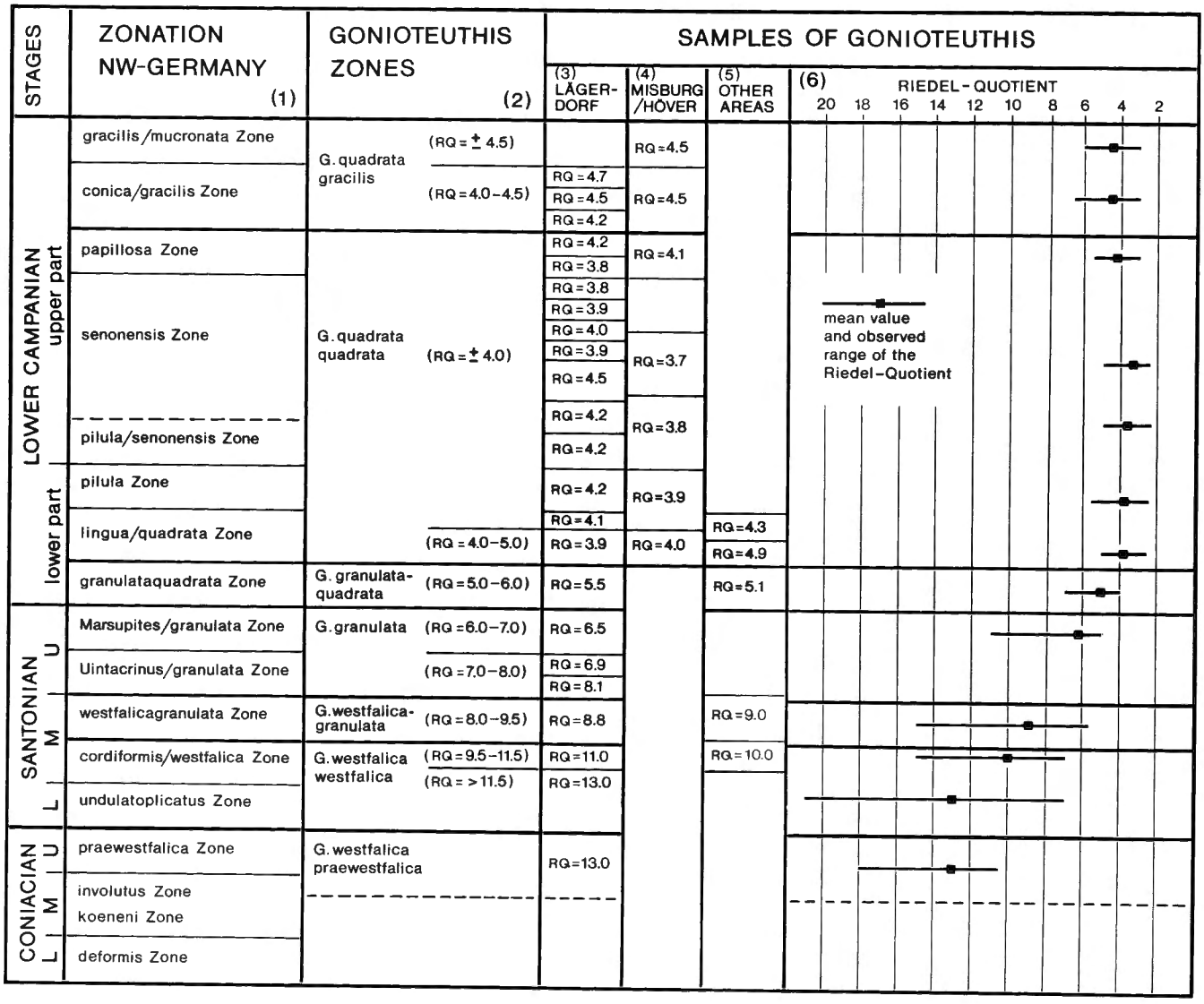

Fig. 2 — Zonation of the Coniacian-Lower Campanian of NW Germany, *Gonioteuthis* zones, and the mean value and observed range of the Riedel Quotient of samples of Gonioteuthis from Lägerdorf, Misburg/Höver at Hannover, and other areas. After CHRISTENSEN (1988).

CHRISTENSEN (1991), and it is valid only for homogeneous samples of a certain size.

DISTRIBUTION: *Gonioteuthis* is known from the upper Middle Coniacian to the boundary between the Lower and Upper Campanian. The extinction level of the genus has been proposed by several authors as the boundary betweeen the Lower and Upper Campanian. The genus had its evolutionary centre in NW Europe and is recorded almost exclusively from the Central European Subprovince. A few specimens are reported from the northernmost part of the Tethyan Realm.

Gonioteuthis westfalica westfalica (SCHLÜTER, 1876)
Pl. 1, Figs. 4-7

SYNONYMY: See CHRISTENSEN (1975a).

TYPE: The original of SCHLÜTER (1876, pl. 53, fig. 10) was designated as lectotype for *G. w. westfalica* SCHLÜTER by ERNST & SCHULZ (1974, p. 50).

REMARKS: The majority of the specimens from the Argile supérieure are *G. westfalica westfalica* (see below). *G. westfalica praewestfalica* ERNST & SCHULZ, 1974, which occurs in the upper Middle and Upper Coniacian (upper part of *Inoceramus involutus* and *I. quadratus* Zones), can only be distinguished from the nominotypical subspecies, which occurs in the Lower and lower Middle Santonian, on the basis of a biometrical analysis (ERNST & SCHULZ, 1974). The main characters separating *praewestfalica* from *westfalica* are the ventrally flattened and club-shaped guard. In addition, *praewestfalica* is not granulated, whereas *westfalica* may be granulated. *G. westfalica praewestfalica* has not been recognized at Lonzée.

DISTRIBUTION: *G. w. westfalica* is common in NW Germany, Scania, and at Lonzée. Outside these areas it has been recorded from most parts of the Central European Subprovince except east of Ukraine. It occurs in the Lower and lower Middle Santonian.

Gonioteuthis westfalicagranulata (STOLLEY, 1897)

SYNONYMY: See CHRISTENSEN (1975a,b).

TYPE: The original of STOLLEY (1897, p. 2, fig. 16; pl. 3, fig. 6) was designated as lectotype and refigured by CHRISTENSEN (1975b, pl. 10, fig. 1; text-fig. 2A).

REMARKS: Some of the specimens from the Argile supérieure are referable to *G. westfalicagranulata* (see below).

DISTRIBUTION: This species occurs in the upper Middle Santonian, *G. westfalicagranulata* Zone.

Gonioteuthis granulata (BLAINVILLE, 1827)

SYNONYMY: See CHRISTENSEN (1975a).

TYPE: The original of BLAINVILLE (1827, pl. 1, fig. 10) was designated as lectotype by CHRISTENSEN (1991, p. 715).

REMARKS: Some of the specimens from the Argile supérieure are referable to *G. granulata* (see below).

DISTRIBUTION: *G. granulata* occurs in the Upper Santonian, *Uintacrinus/G. granulata* and *Marsupites/G. granulata* Zones.

Gonioteuthis granulataquadrata? (STOLLEY, 1897)
Pl. 1, Figs. 10-13

SYNONYMY: See CHRISTENSEN (1975a,b).

TYPE: The original of STOLLEY (1897, p. 2, fig. 23; pl. 3, fig. 13) was designated as lectotype and refigured by CHRISTENSEN (1975b, pl. 10, fig. 2, text-fig. 2B).

REMARKS: Two specimens (IRSNB MI 10628-9) with a stout guard and a deep pseudoalveolus may be *G. granulataquadrata* (see below).

DISTRIBUTION: *G. granulataquadrata* occurs in the basal Lower Campanian, *G. granulataquadrata* Zone.

BIOMETRIC ANALYSIS OF *GONIOTEUTHIS* FROM THE ARGILE SUPÉRIEURE, Collection IG 11039

UNIVARIATE ANALYSIS

The mean value of the Riedel-Quotient of 60 specimens is 11.3, and the observed range is 5.1-37.7. On the basis of the mean value of the Riedel-Quotient only the sample is referable to *G. w. westfalica* (Fig. 2). Samples of *G. w. westfalica* from elsewhere, however, do not exhibit such a large variation with respect to the Riedel-Quotient, implying that the sample from Lonzée is heterogeneous. According to ERNST (1968, Fig. 7) specimens with a Riedel- Quotient < 5 in homogeneous samples of *Gonioteuthis* occur for the first time in the basal Lower Campanian *G. granulataquadrata.*

BIVARIATE ANALYSIS

The scatter plots of the length of the guard vs the depth of the pseudoalveolus, and the length of the guard vs the dorso-ventral diameter at the alveolar end are shown in Figs 3A-B.

Length of the guard vs depth of the pseudoalveolus. – The scatter plot shows that there is a great variation with respect to the depth of the pseudoalveolus, indicating

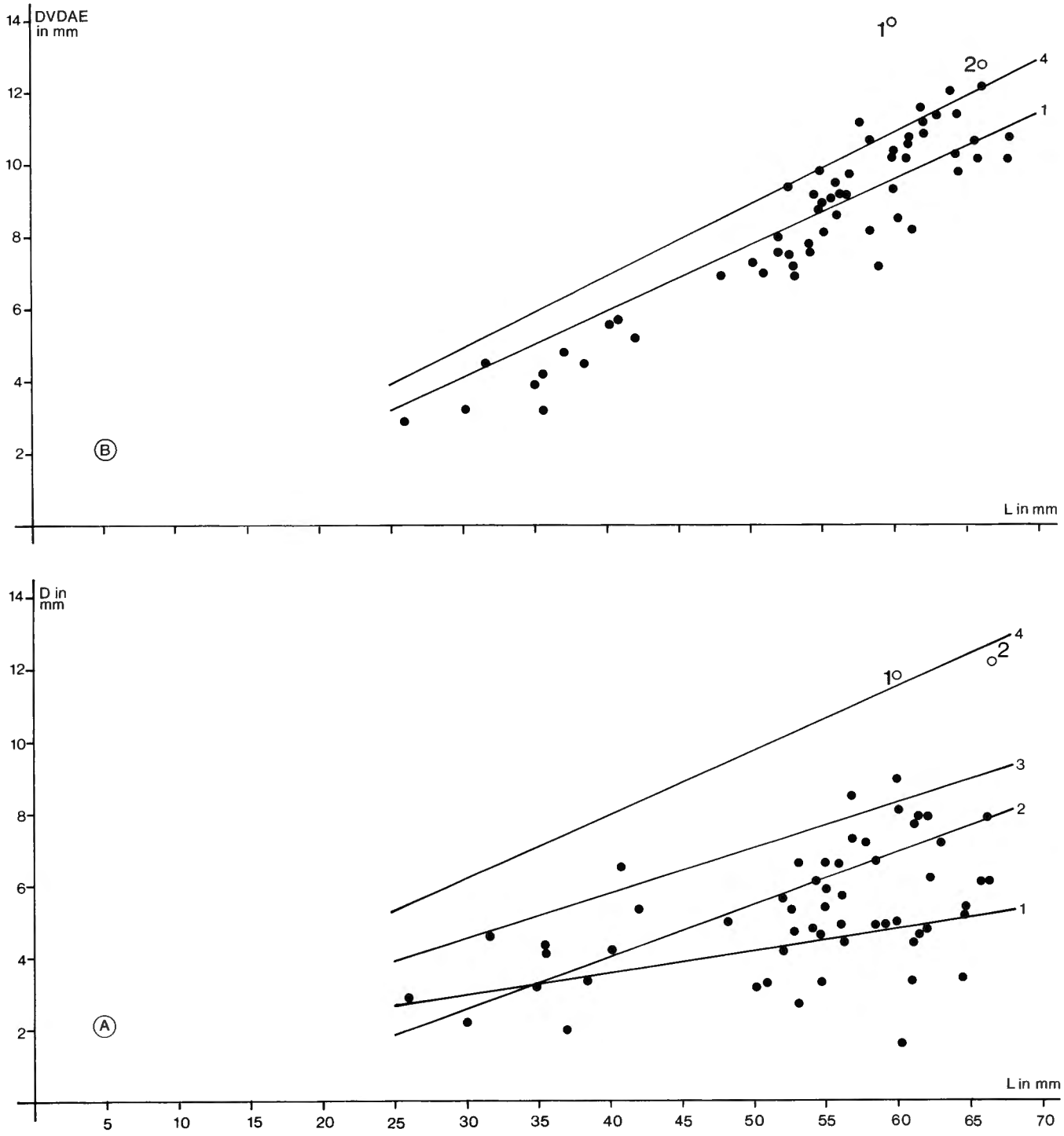

Fig. 3 — Scatter plots of the length of the guard vs the depth of the pseudoalveolus (A), and length of the guard vs the dorso-ventral diameter at the alveolar end (B). L = length of the guard; D = depth of the pseudoalveolus; and DVDAE = dorso-ventral diameter at the alveolar end. Regression lines of four species of *Gonioteuthis* are superimposed in Fig. 3A, and regression lines of two species are superimposed in Fig. 3B. 1 is IRSNB MI 10629; 2 is IRSNB MI 10628.

that the sample is not homogeneous (see above). Four regression lines, calculated on the basis of homogeneous samples of *Gonioteuthis* from well known stratigraphic horizons in NW Germany, are superimposed onto the scatter plot:

1) *G. w. westfalica*, Essen-Vogelheim, lower '*westfalica* beds' (ERNST, 1964, p. 118; CHRISTENSEN, 1975a, p. 38).

2) *G. westfalicagranulata*, Bülten, (ERNST, 1968, p. 278; CHRISTENSEN, 1975a, p. 38).

3) *G. granulata*, Gleidingen (ERNST, 1968, p. 278; CHRISTENSEN, 1975a, p. 38).

4) *G. granulataquadrata*, Weinberg (ERNST, 1968, p. 278; CHRISTENSEN, 1975a, p. 38).

It is obvious that most of the specimens from Lonzée are scattered around the regression line 1 for *G. w. westfalica*. Most of the specimens from Lonzée are therefore referable to this subspecies. Since it is necessary to analyse homogeneous samples of *Gonioteuthis* in order to make a reliable specific determination, it is not possible with safety to assign specimens with a deeper pseudoalveolus to other species of *Gonioteuthis*. On the basis of the scatter plot, however, it seems that at least *G. westfalicagranulata* and *G. granulata* are also present in the analyzed sample. Specimens nos IRSNB IM 10628-9 have a rather deep pseudoalveolus and lie very close to the regression line for *G. granulataquadrata*.

Length of the guard vs dorso-ventral diameter at the alveolar end. – Two regression lines of samples of *Gonioteuthis* are superimposed on the scatter plot:

1) *G. w. westfalica*, Essen-Vogelheim, lower '*westfalica* beds' (ERNST, 1964, p. 118; CHRISTENSEN, 1975a, p. 39).

2) *G. granulataquadrata*, Weinberg (ERNST, 1968, p. 279; CHRISTENSEN, 1975a, p. 39).

Regression lines of the samples of *G. westfalicagranulata* and *G. granulata* have not been made, because data are not available. It is obvious from Fig. 3B that most of the specimens from Lonzée are scattered around the regression line for *G. w. westfalica*. The two specimens with a deep pseudoalveolus (IRSNB MI 10628-9) are more stout than *G. w. westfalica*.

CONCLUSION: The majority of the specimens from the Argile supérieure at Lonzée are *G. w. westfalica*, but younger species of the genus are also present, at least *G. westfalicagranulata* and *G. granulata*, and possibly *G. granulataquadrata*.

***Gonioteuthis* sp.**

MATERIAL: One nearly-complete specimen and two alveolar fragments from the Argile inférieure.

DISCUSSION: The critical characters of the nearly-complete specimen are as follows: length of the guard: 58 mm; depth of the pseudoalveolus: 7.0 mm; dorso-ventral diameter at the alveolar end: 10.4 mm; lateral diameter at the alveolar end: 10.3 mm; maximum lateral diameter: 11.3 mm; Riedel- Quotient: 8.3; Slenderness-Quotient (length of the guard divided by the dorso-ventral diameter at the alveolar end): 5.6. It is granulated on the dorsal field and does not have a ventral fissure or ventral furrow. It has, however, a ventral notch anteriorly.

On the basis of the Riedel-Quotient, the specimen is either *G. westfalica*, *G. westfalicagranulata*, or *G. granulata*. It may be *G. westfalicagranulata* due to its granulation and lack of a ventral fissure or furrow, but a definite specific determination is not possible.

AGE OF THE GLAUCONIE AT LONZÉE

The Argile inférieure has yielded four specimens of *A. verus* and one nearly-complete specimen of *Gonioteuthis*, which is either *G. westfalica*, *G. westfalicagranulata*, or *G. granulata*.

The Argile supérieure has yielded *Gonioteuthis* spp. and *A. verus*. The following species of *Gonioteuthis* are present: *G. w. westfalica*, *G. westfalicagranulata*, *G. granulata*, and possibly *G. granulataquadrata*.

The age of the two lithological units cannot be differentiated on the basis of the belemnites. The maximum age of the section at Lonzée is thus Early Santonian to basal Early Campanian (*G. granulataquadrata* Zone), and the minimum age is Santonian.

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Walter Kegel Christensen,
Geological Museum,
University of Copenhagen,
Öster Voldgade 5-7,
DK-1350 Copenhagen,
Denmark

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