Bivalves from the white chalk (Maastrichtian) of Denmark: Limopsidae

CLAUS HEINBERG

Heinberg, C.: Bivalves from the white chalk (Maastrichtian) of Denmark: Limopsidae. *Bull. geol. Soc. Denmark,* vol. 25, pp. 57–70. Copenhagen, October, 22nd, 1976. https://doi.org/10.37570/bgsd-1976-25-07

Eight new species of Limopsis (Bivalvia) from the white chalk (Maastrichtian) of Denmark are described and quantitatively characterised by selected parameters.

C. Heinberg, Institute of historical Geology and Palaeontology, Øster Voldgade 10, DK-1350 Copenhagen K, Denmark. June 1st, 1976.

This paper is intended to be the first in a series with descriptions of about 40 new species of aragonitic bivalves from the white chalk (Maastrichtian) of Denmark.

The white chalk sequence of Denmark is up to 700 m thick and consists of a rather pure and unconsolidated sediment composed largely of coccoliths (Håkansson et al. 1974). At Stevns Klint the uppermost part of the sequence is developed as a bryozoan bioherm facies.

Hardgrounds, showing various degrees of development, occur at a number of levels. The most prominent hardgound is found at the very top of the sequence, truncating the bioherm tops and cementing the final Mesozoic sediments.

In contrast to the soft chalk, the hardgrounds contain a fauna of aragonitic bivalves as well as gastropods. The shells are preserved as voids owing to the dissolution of the original shell material. Latex casts of excellent quality may be made of the voids.

The top hardground found at Stevns Klint is the only one in the chalk of Denmark that is thick enough to provide material on a larger scale. This hardground cuts alternately through Danian and Maastrichtian sediments, representing basin fillings and truncated bioherms respectively (fig. 1). This rather complex structural pattern has been described in detail by Rosenkrantz (1966) who also has discussed the faunistic differences between the indurated white chalk (Maastrichtian) and the Danian part of the hardground, which is known as the Cerithiumkalk (Rosenkrantz 1924, 1939). Previously, Ravn (1902) described a number of bivalves, mainly calcitic, from the Maastrichtian and the Danian. Unfortunately he did not distinguish between Maastrichtian and Danian parts of the hardground, and called the entire compound indurated layer "Cerithiumkalk".

In order to obtain a semiquantitative collection of fossils, the hardground has been carefully examined at a number of localities (fig. 2), resulting in a collection of about 1000 specimens of aragonitic bivalves. Additional material was examined from the collection of A. Rosenkrantz.

Biometry

In order to obtain a quantitative basis for the functional morphological and the ecological interpretation (in preparation) a number of parameters (fig. 3) and indices were selected.

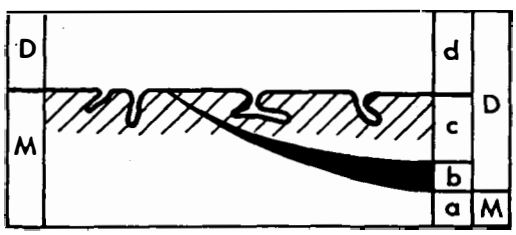

Fig. 1. Schematic section of the Maastrichtian/Danian boundary at Stevns Klint. M: Maastrichtian, D: Danian, Hatching: hardground. a: white chalk, b: Fiskeler, c: Cerithiumkalk, d: bryozoan limestone, also filling the burrows in the hardground. Modified from Rosenkrantz 1966.

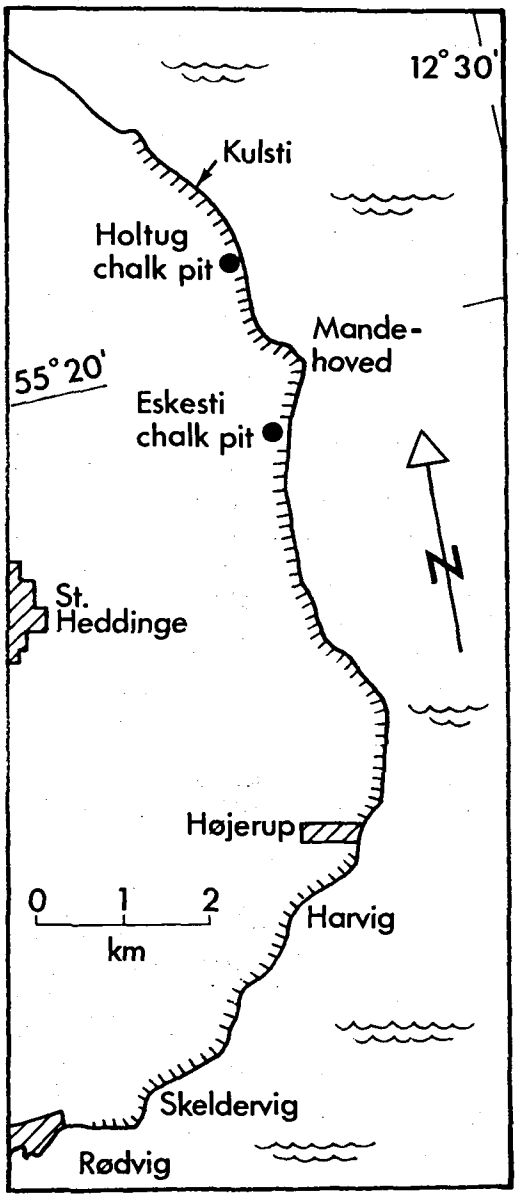

Fig. 2. Map of the eastern part of Stevns, showing the extent of the cliff and the most important localities.

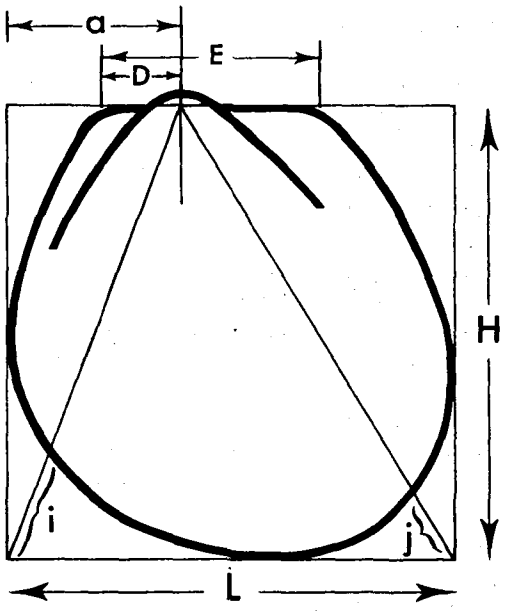

Fig. 3. Parameters used in biometric analyses of the species of Limopsis. *H: height, L: length, a: distance from umbo to the anterior axes, E: length of hinge line, D: part of the hinge line anterior of the umbo, i and j: distances from the point of intersection between the ventral axis and the anterior and posterior axes respectively to the shell margin, measured along a line running from a point on the cardinal axis just below the umbo to the intersections mentioned above. W: width (not on figure).*

These were measured, calculated and plotted against height (H). All measurements were taken from drawings of the steinkern made with a camera lucida. The method involves a certain inacuracy which has been calculated to be less than 4 %, a magnitude which does not alter the diagrams significantly. The diagrams illustrate important morphological features and trends of the species, as well as differences between the individual species. In some cases where the number of specimens was considered large enough, regression lines were calculated (least squares method).

The indices are as follows:

The inequilaterality index a/L, showing the position of the umbo relative to the length of the shell.

The obliquity index i/j, illustrating the size of the posteroventral shell corner relative to the anteroventral one.

The umbo-hinge index D/E, which illustrates the length of the hinge line anterior to the umbo, relative to the total length of the hinge line.

Width W, maximum distance between the outer surfaces of the shells, measured perpendicular to plane of commissure.

Systematic descriptions

The descriptions are based on latex casts. All types and figured material are in the type collection of the Geological Museum of the University of Copenhagen (numbers with MGUH).

All the names of the new species, except *ravni*, are derived from female names.

The individual species are only referred to genera since the subgeneric taxa available (Moore 1969) only cover the morphological types in consideration to a very limited degree.

Family: Limopsidae Dall, 1895
Genus: *Limopsis* Sassi, 1827
Type species: *Arca aurita* Brocchi, 1814

Limopsis alvildae n.sp.
Figs. 4 & 5
Holotype: MGUH 13718. Height: 6.3 mm, length: 6.3 mm, width: 3.3 mm.

Type locality: Stevns Klint.

Type stratum: The top hardground in the Upper Maastrichtian white chalk.

Diagnosis: A nearly equilateral smooth *Limopsis*, flat lenticular in shape, subcircular in outline, umbo moderate, anterior shell margin smooth, posterior shell margin crenulated, the crenulae continuing on the inside as radiating ribs, small anterior myophore.

Description: The shell is equivalve, relatively flat lenticular with a subcircular outline. It is nearly equilateral, the umbo having a slightly prosocline position. The umbo is orthogyrate moderate in size and projects dorsally. The hinge line is straight, the rest of the margin forming a gentle curve that meets the hinge line at a more obtuse angle posteriorly than anteriorly. The cardinal area is flat, oblique triangular with a small resilifer below the umbo. The dentition is divided into two series by an edentulous gap. The anterior series consists of up to 3 parallel, dorso-ventrally orientated teeth, the posterior of up to 4 teeth that radiate with respect to a point below the umbo. The shell surface is smooth, with regularly spaced growth lines. The anterior half of the shell margin is smooth whereas the posterior is crenulated, the crenulae continuing as weak radiating ribs on the inside of the shell, the

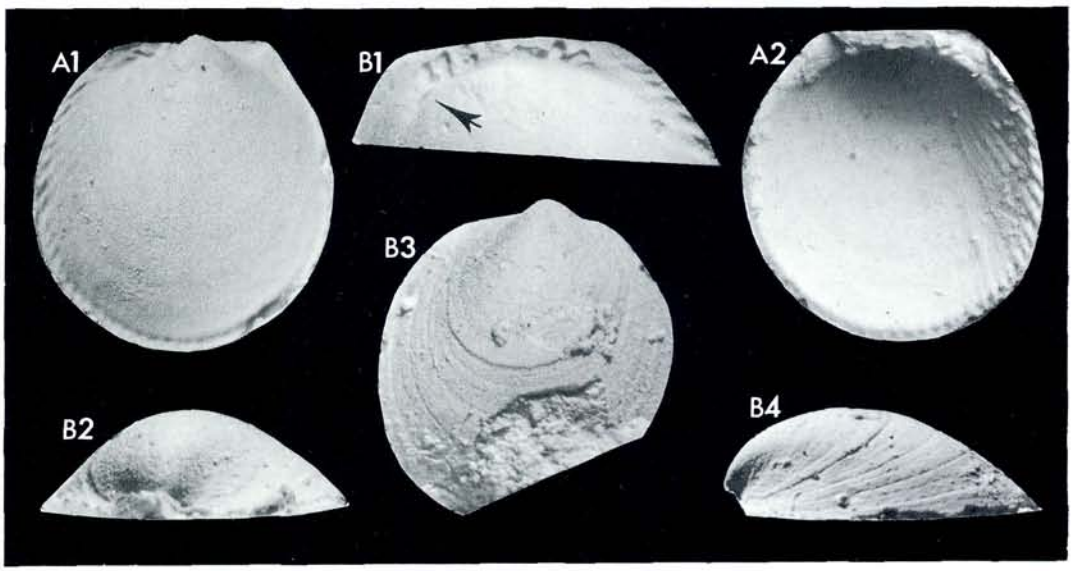

Fig. 4. Limopsis alvildae *n.sp. A 1: Steinkern showing the inside of a right valve. Holotype. MGUH 13718. × 7. A 2: Inside of a right valve. Latex cast of MGUH 13718. Holotype. × 7. B 1: Hinge of a right valve. Note myophore. Latex cast of MGUH 13719. × 13. B 2, B 3, B 4: Outside of a right valve seen in dorsal, lateral and anterior view. Latex cast of MGUH 13719. × 9.*

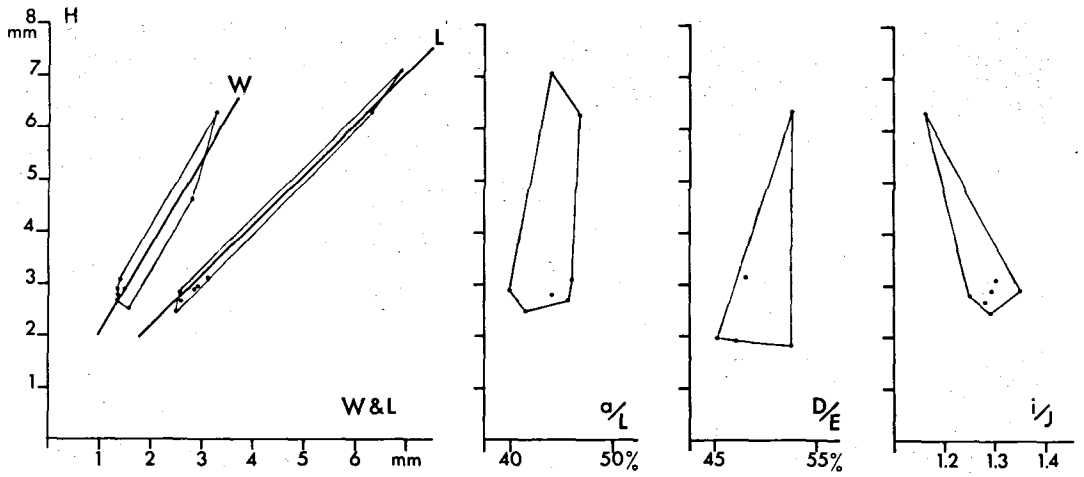

Fig. 5. Diagrams showing morphological parameters and indices of Limopsis alvildae *n.sp. plotted against height. For explanation see text. See fig. 3 for abbreviations and definitions.*

rest of which is smooth. There is a minute myophore immediately below the anterior part of the hinge plate.

Maximal dimensions: Height: 6.8 mm, length: 6.8 mm, width: 4.2 mm.

Shape indices: Fig. 5. There is isometric growth in both the length/height and the length/width relations. There seems to be a rather constant inequilaterality value around 44 %, but here as well as in the D/E and i/j relations the number of measurements are too few to be conclusive.

Affinities: The species shows resemblance to *Limopsis altera* Deshayes (Cossmann & Pissarro 1903) with respect to the crenulation of the posterior shell margin, but it differs from that species by being less prosocline and by having a smooth outer surface.

Material: 13 specimens from Stevns Klint, comprising 4 from north of Holtug chalk pit, 4 from north of Kulsti, 2 from Rødvig and 3 from other parts of the cliff.

Limopsis amandae n.sp.
Figs. 6 & 7

Holotype: MGUH 13720. Height: 15.1 mm, length: 15.6 mm, width: 11.2 mm.

Type locality: Stevns Klint immediately north of Eskesti chalk pit.

Type stratum: The top hardground in the Upper Maastrichtian white chalk.

Diagnosis: A relatively large *Limopsis* highly inflated, almost equilateral with a subcircular outline; umbo prominent, orthogyrate; projecting dorsally; shell margin and inside of shell smooth, outside smooth with growth lines; small myophore.

Description: The shell is equivalve, orbicular with a subcircular outline. It is nearly equilateral, the umbo having a slightly prosocline position. The prominent umbo is orthogyrate, projecting dorsally. The hinge line is straight, the rest of the margin forming a gentle curve. The cardinal area is flat, triangular with a relatively large triangular resilifer below the umbo, both striated parallel to hinge line. The resilifer is divided into a median and two lateral sections, reflecting the alivincular type of the ligament. The dentition is divided into two series by a rather wide edentulous gap below the umbo. The straight anterior series consists of up to 7 teeth that radiate with respect to a point far below the umbo, near the ventral margin. The arched posterior series consists of up to 11 teeth, radiating with respect to a point below the anteriormost tooth of the series. The shell surface is smooth with numerous growth lines. The shell margin is smooth as well as the inside of the shell. There

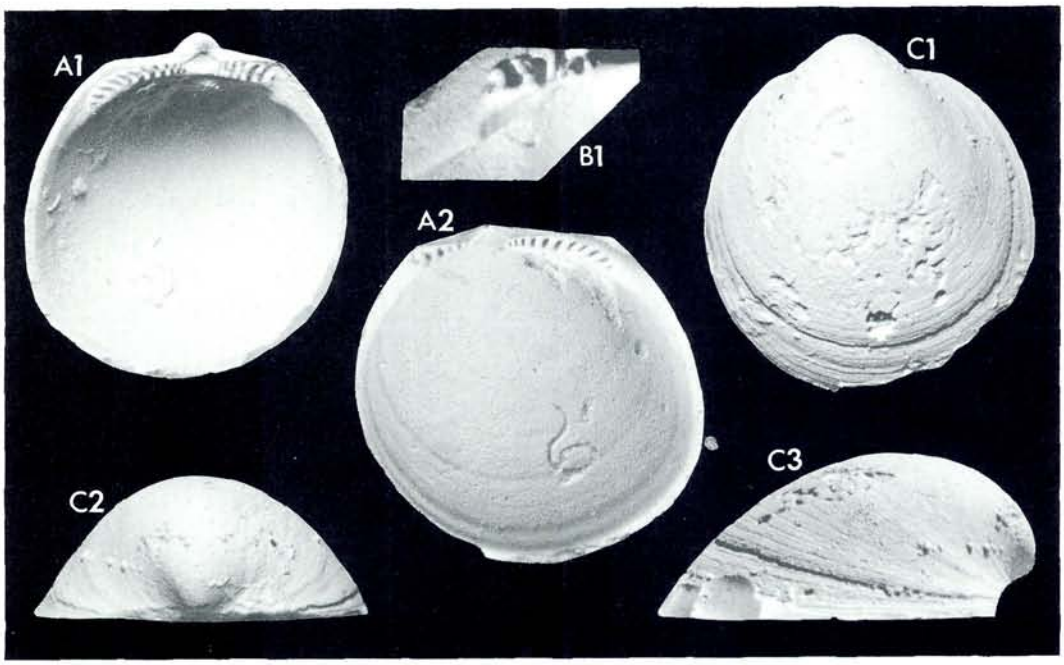

Fig. 6. Limopsis amandae *n.sp. A 1: Inside of a left valve. Latex cast of the holotype. MGUH 13720. × 3. A 2: Steinkern showing the inside of a left valve (umbonal filling is missing). Holotype. × 3. B 1: Anterior myophore of a right valve. Latex cast of MGUH 13721. × 10. C 1, C 2, C 3: Outer surface of a left valve, seen in lateral, dorsal and posterior views. MGUH 13722. × 3.*

is a small myophore below the anterior part of the hinge plate.

Maximal dimensions: Those of the holotype.

Shape indices: The species (fig. 7) shows isometric growth in the length/height relationship but clear allometrical growth in the width/height ratio. The inequilaterality seems to lie constant around 44 % through growth; a similar constancy is also found in the obliquity index (i/j) around the 1.18 value. The umbo-hinge index (D/E) shows a tendency to decrease with growth. If these values are conclusive it can be said that apart from the width, which increases relatively, the animal retains a constant shape throughout life.

Affinities: The affinity to *Limopsis magdae* n.sp. is discussed under that species.

Material: 36 specimens from Stevns Klint, comprising 13 from north of Holtug chalk pit, 10 from Rødvig, 6 from Skeldervig, 4 from north of Eskesti chalk pit and 3 from north of Kulsti.

Limopsis magdae n.sp.
Figs. 7 & 8

Holotype: MGUH 13723. Height: 13.5 mm, length: 13.3 mm, width: 10.1 mm.

Type locality: Stevns Klint at Harvig.

Type stratum: The top hardground in the Upper Maastrichtian white chalk.

Diagnosis: A relatively large, highly inflated, almost equilateral *Limopsis*, ovate in outline; umbo prominent, projecting dorsally, shell margin crenulated, inside of shell smooth, outside smooth with rather densely spaced growth lines. Resilifer large.

Description: The shell is equivalve, orbicular with an oblique, ovate outline. It is nearly equilateral, the umbo having a slightly prosocline position. The prominent umbo is orthogyrate, projecting dorsally. The hinge line is straight, the rest of the margin forming a gentle curve. The cardinal area is flat, triangular, with a large triangular resilifer below the umbo both striated parallel to hinge line. The dentition is divided into two series by a narrow

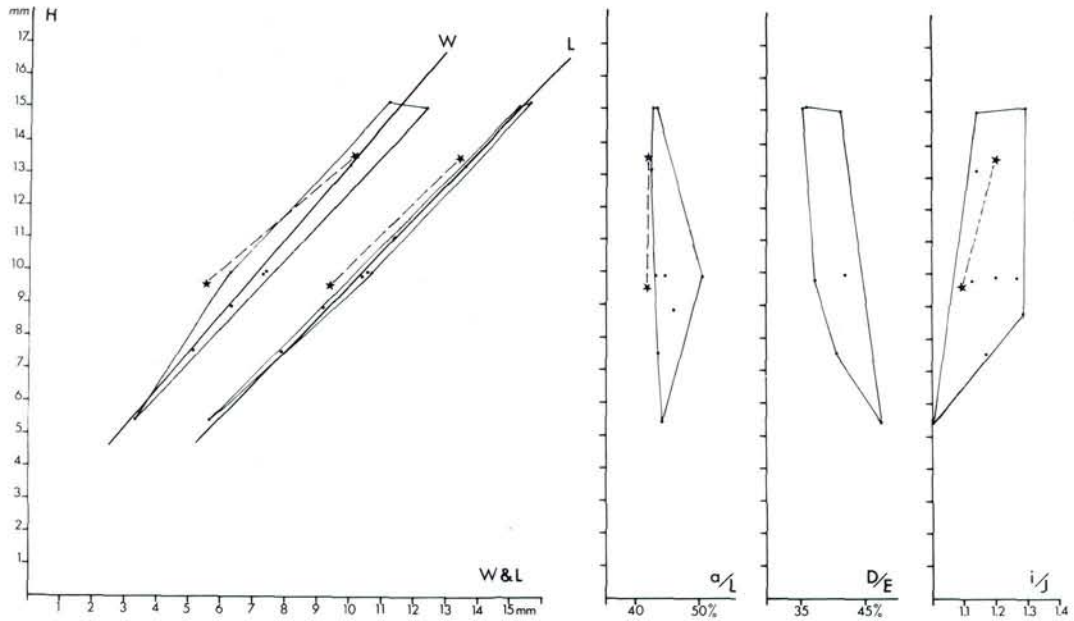

Fig. 7. Diagrams showing morphological parameters and indices of Limopsis amandae *n.sp. (dots) and* L. magdae *n.sp. (stars) plotted against height. For explanation see text. See fig. 3 for abbreviations and definitions.*

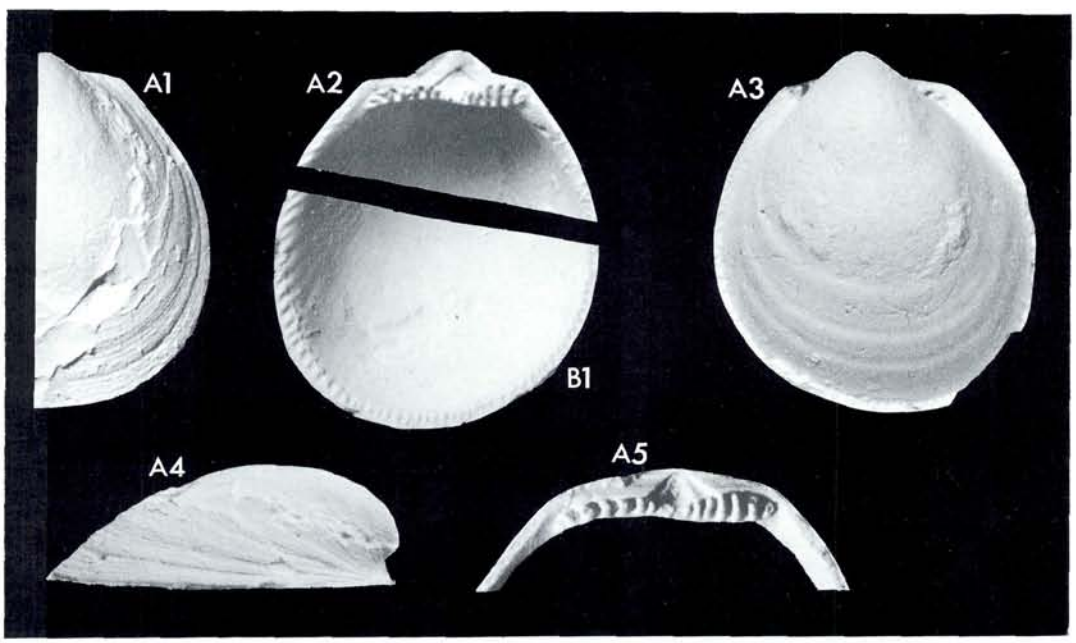

Fig. 8. Limopsis magdae *n.sp. A 1: Outer surface of a left valve. Latex cast of the holotype, MGUH 13723. × 4. A 2: Hinge area of a left valve. Latex cast of the holotype. × 4. A 3: Steinkern showing the inside of a left valve. Holotype. × 4. A 4: Outer surface of a left valve seen in posterior view. Latex cast of the holotype. × 4. A 5: Part of fig. 2 enlarged to show resilifer and hinge teeth. B 1: Inside of a left valve, ventral half. Latex cast of 13724. × 5.*

edentulous gap. The anterior series consists of up to 7 teeth, the posterior of up to 6. The two series form an almost straight row of teeth, the majority of which are dorsoventrally orientated, the posteriormost radiating with respect to a point close below the umbo. The shell surface is smooth with numerous growth lines. The shell margin is crenulated, mainly along the inner edge. The inside is smooth, except for the posterior part which carries some radiating ribs caused by the crenulae. There is no myophore.

Maximal dimensions: Those of the holotype.

Shape indices: The magnitude of the shape indices from two specimens is shown in fig. 7. Because of the small material nothing conclusive can be said about ontogenetic trends.

Affinities: The species differs from *Limopsis amandae* n.sp. by the crenulated margin and the absence of a myophore. It has the crenulations in common with the subgenus *Pectunculina*, from which it differs in most other relevant characters.

Material: 5 specimens from Stevns Klint, comprising two from north of Holtug chalk pit, two from Harvig and one from north of Eskesti chalk pit.

Limopsis nanae n.sp.
Figs. 9 & 10

Holotype: MGUH 13725. Height: 2.3 mm, length: 2.3 mm, width: 1.3 mm.

Type locality: Stevns Klint, at Rødvig.

Type stratum: The top hardground in the Upper Maastrichtian white chalk.

Diagnosis: A small prosocline, concentrically ribbed *Limopsis*, lenticular in shape, oblique subcircular in outline, umbo weak, shell margin with concentric striae not parallel with the edge, small anterior myophore.

Description: The shell is equivalve, lenticular. The outline is subcircular with a faintly projecting posteroventral region. It is moderately inequilateral, prosocline with a weak orthogyrate umbo forming a moderately steep anterodorsal slope. The hinge line is straight, the rest of the margin forms a gentle curve except for the most anterodorsal part where it becomes straight. The cardinal area is flat, oblique triangular with a small triangular resilifer

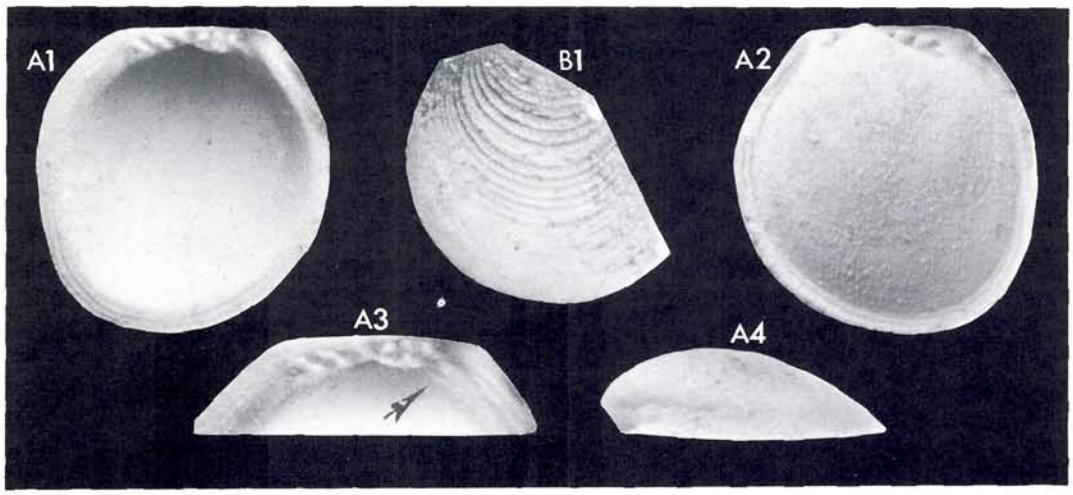

Fig. 9. Limopsis nanae *n.sp. A 1: Inside of a left valve. Latex cast of the holotype, MGUH 13725. × 17. A 2: Steinkern showing the inside of a left valve. Holotype. × 17. A 3: Hinge area of fig. 1, enlarged to show the anterior myophore. × 23. A 4: Steinkern showing the inside of a left valve in anterior view. Holotype. × 17. B 1: Outer surface of a left valve. Latex cast of 13726. × 16.*

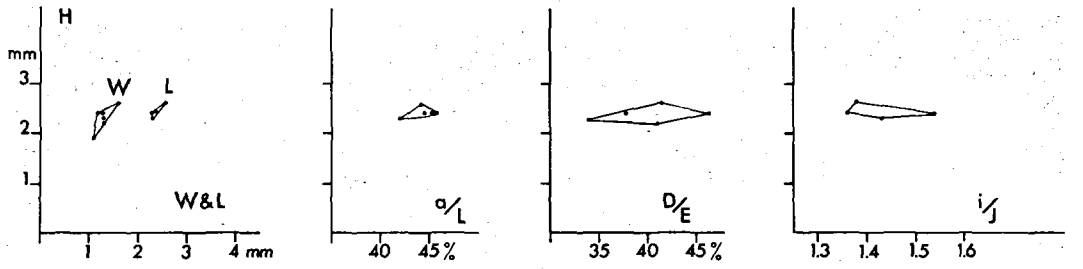

Fig. 10. Diagrams showing morphological parameters and indices of Limopsis nanae *n.sp. plotted against height. For explanation see text. See fig. 3 for abbreviations and definitions.*

below the umbo. The dentition is divided into two series by a very narrow edentulous gap, hardly wider than a single tooth socket. The straight anterior series is short, consisting of up to 3 parallel dorso-ventrally orientated hinge teeth, the posterior series of up to 4 teeth radiates with respect to a point situated anteroventrally of the umbo. The sculpture consists of prominent concentric ribs (ca. 11 between 1 and 2 mm from the umbo). The shell margin is ornamented with concentric ribs diverging from the edge towards the hinge. The inside of the shell is smooth. The hinge plate curves dorsally at the anterior end to give room for a small myophore situated immediately ventral to it.

Maximal dimensions: Height: 2.6 mm, length: 2.6 mm, width: 1.6 mm.

Shape indices: Fig. 10 shows the magnitude of the shape indices. Since the range of size is small and the number of specimens low, nothing conclusive can be said about ontogenetic trends.

Affinities: The peculiar concentric sculpture of the shell margin renders this a distinctive species.

Material: 10 specimens from Stevns Klint comprising 4 from Rødvig, 4 from north of Eskesti chalk pit, 1 from north of Holtug chalk pit and 1 from Kulsti.

Limopsis ravni n.sp.
Figs. 11 & 12
1902 *Limopsis höningshausii* Müller: Ravn, p. 124

Derivation of name: After J. P. J. Ravn, who described the species from Stevns Klint.

Holotype: MGUH 13727. Height: 3.6 mm, length: 3.8 mm, width: 2.4 mm.

Type locality: Stevns Klint, immediately north of Holtug chalk pit.

Type stratum: The top hardground in the Upper Maastrichtian white chalk.

Diagnosis: A prosocline, concentrically ribbed *Limopsis* with inflated umbonal region, prominent umbo projecting dorsally and relatively steep anterodorsal slope; anterior myophore prominent.

Description: The shell is equivalve, obliquely subcircular with a prominent posteroventral region. It is inequilateral, prosocline, with a strongly inflated umbonal region forming a relatively steep anterodorsal slope. The inside of the slope is almost perpendicular to the median plane. The umbo is prominent, orthogyrate. The hinge line and the dorsal half of the anterior margin are straight, together forming an obtuse angle; the ventral half of the anterior margin gently curves into the ventral margin and further into the posterior margin which forms an obtuse angle with the hinge line. The cardinal area is flat, oblique triangular with a small and deep triangular resilifer below the umbo; both faintly striated parallel to hinge line. The dentition is divided into two series separated by an edentulous gap below the umbo. The anterior series is straight and consists of up to 5 parallel dorso-ventrally orientated hinge teeth, the posterior series of up to 8

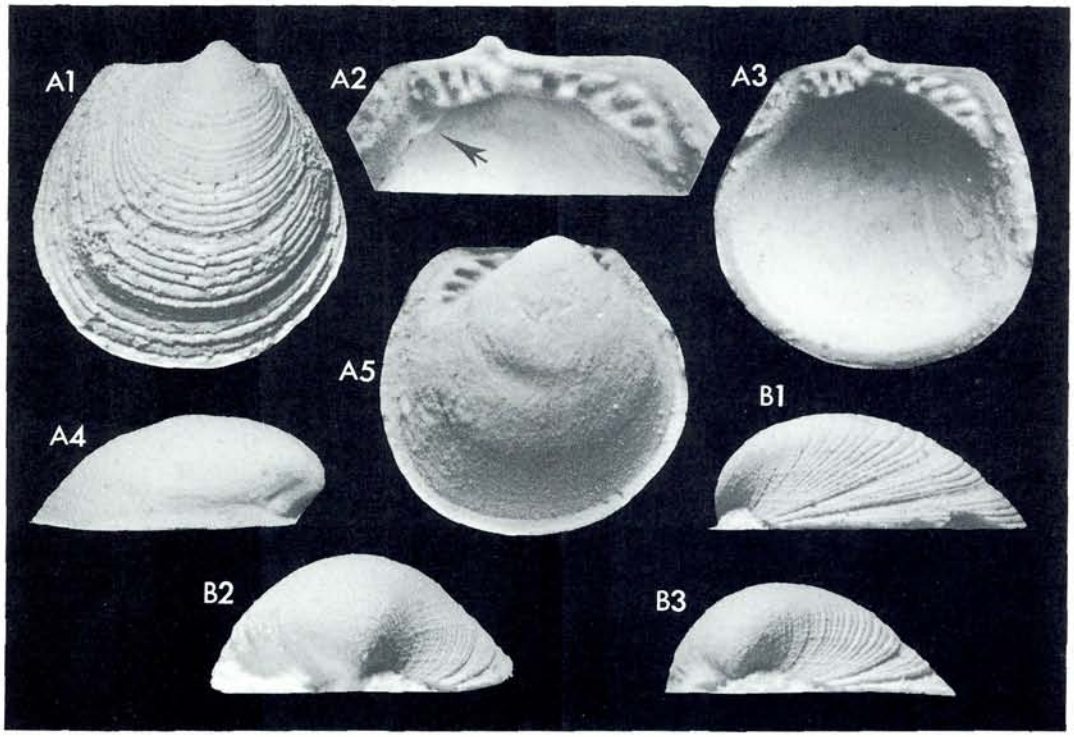

Fig. 11. Limopsis ravni *n.sp. A 1: Outer surface of a right valve seen in lateral view. Latex cast of the holotype. MGUH 13727. × 10. A 2: Hinge area of a right valve showing the myophore. Latex cast of holotype. × 14. A 3: Inside of a right valve. Latex cast of holotype. × 10. A 4, A 5: Steinkern of a right valve seen in anterior and lateral view. Holotype. × 10. B 1, B 2, B 3: Outer surface of a right valve seen in posterior view, dorsal view, and parallel to the sole. Latex cast of MGUH 13728 × 10.*

teeth is arched, and the teeth radiate with respect to a point below the resilifer. The sculpture consists of prominent concentric ribs (7 per mm, 2 mm from the umbo) and weeker radial ribs (2 per mm, 2 mm from the umbo). The shell margin is smooth. The inside of the shell is smooth with a well developed myophore below the anterior part of the hinge plate.

Maximal dimensions: Height: 5.6 mm, length: 5.8 mm, width: 3.9 mm.

Shape indices: Fig. 12. The species shows isometric growth with respect to the height/length relationship, but distinctly allometric growth in the width/height ratio. In specimens 2.5 mm high the width constitutes 50 % of the height, whereas in specimens with a height of 5 mm the same ratio is 80 %.

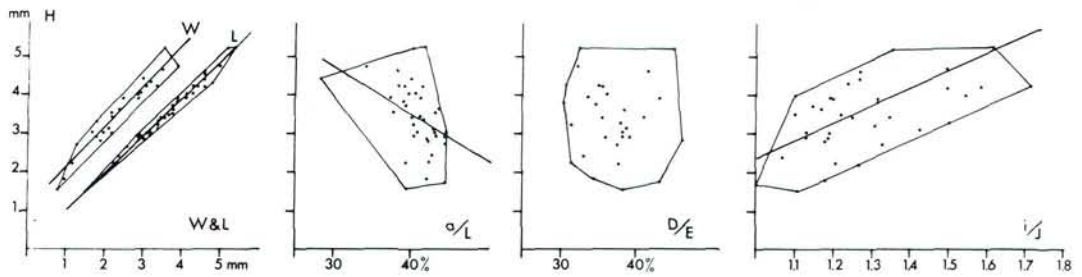

Fig. 12. Diagrams showing morphological parameters and indices of Limopsis ravni *n.sp. plotted against height. For explanation see text. See fig. 3 for abbreviations and definitions.*

The inequilaterality index (a/L) and the obliquity index (i/j) also vary allometrically with respect to the height. The umbo-hinge index (D/E) shows no clear trend with respect to growth.

Generally the species becomes more inequilateral and relatively thicker with growth, the juveniles being flatter and more circular in outline.

Affinities: *L. ravni* is morphologically closely related to *L. augustae* n.sp. from which it differs by being less prosocline (a D/E value of 28 % separates the two species), by being less oblique, having a less steep anterodorsal flank and by the absence of a myophore in the latter.

From *Pectunculus höninghausii* Müller (Müller 1847, table 1, fig. 6), to which Ravn (1902) assigned the species, it differs clearly with respect to the anterodorsal shell corner, which forms an acute angle in *P. höninghausii*, and with respect to the anterior edge, which is concave in *P. höninghausii*, and straight to convex in *L. ravni*.

Material: 91 specimens from Stevns Klint, comprising 22 from the type locality at Holtug, 22 from Rødvig, 20 from north of Eskesti chalk pit and 28 from various other parts of the cliff.

Limopsis augustae n.sp.
Figs. 13 & 14

Holotype: MGUH 13729. Height: 2.9 mm, length: 3.1 mm, width: 1.9 mm.

Type locality: Stevns Klint, at Rødvig.

Type stratum: The top hardground in the Upper Maastrichtian white chalk.

Diagnosis: A strongly prosocline, concentrically ribbed *Limopsis* with inflated umbonal re-

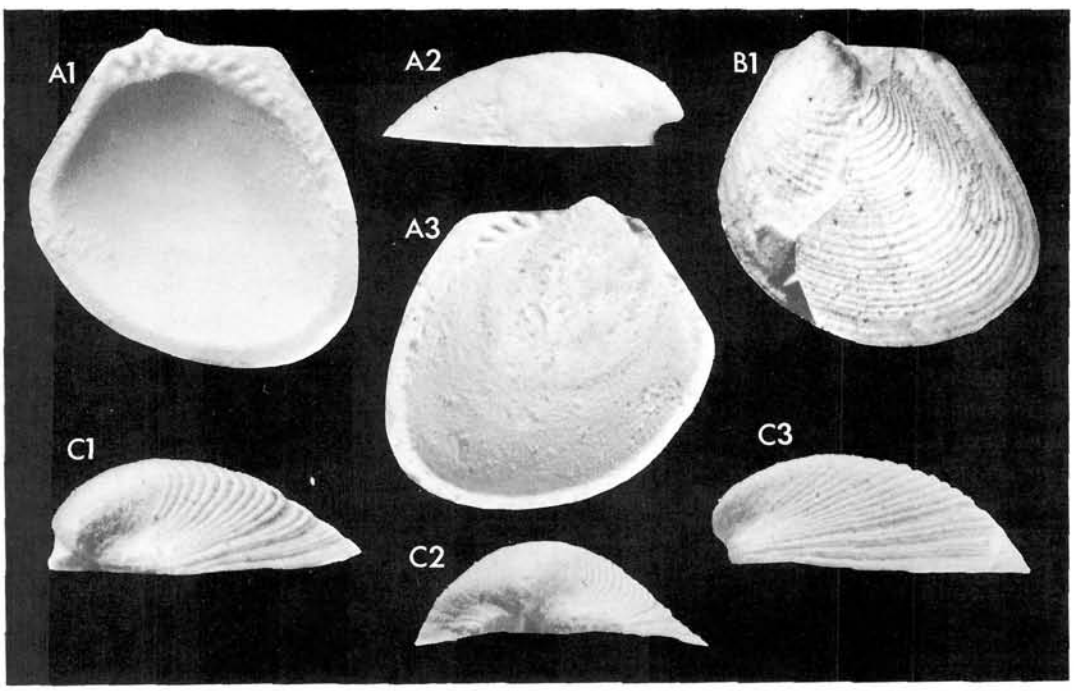

Fig. 13. Limopsis augustae *n.sp. A 1: Inside of a right valve. Latex cast of the holotype, 13729. × 14. A 2: Steinkern showing the inside of a right valve in anterior view. Holotype. × 14. A 3: Steinkern showing the inside of a right valve in lateral view. Holotype. × 14. B 1: Outer surface of a left valve. (Two parts of the shell photographed separately, and then reassembled). Latex cast of MGUH 13730. × 12. C 1, C 2, C 3: Outer surface of a right valve, seen parallel to sole, in dorsal and in posterior view. Latex cast of MGUH 13731. × 12.*

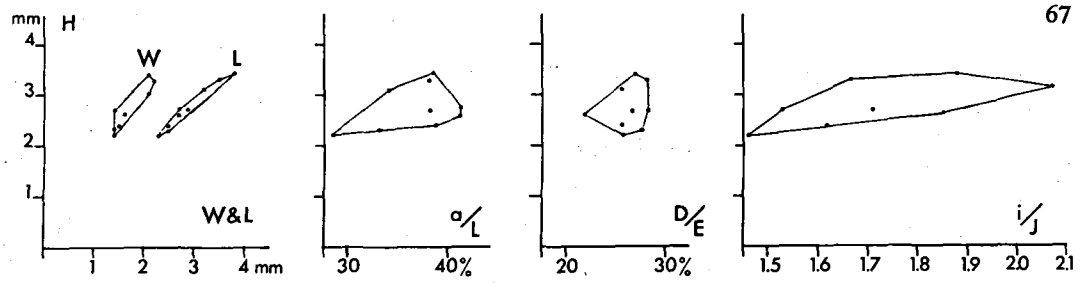

Fig. 14. Diagrams showing morphological parameters and indices of Limopsis augustae *n.sp. plotted against height. For explanation see text. See fig. 3 for abbreviations and definitions.*

gion, prominent umbo projecting dorsally and steep anterodorsal slope; anterior myophore absent.

Description: The shell is equivalve, rounded triangular with a prominent posteroventral region. It is strongly inequilateral, prosocline, with a strongly inflated umbonal region forming a steep anterodorsal slope, thus reducing the anterior shell corner. The inside of the slope is overhanging to perpendicular to the median plane. The umbo is prominent, orthogyrate. The hinge line and the dorsal half of the anterior margin are straight, together forming an obtuse angle; the rest of the margin forms a gentle curve with maximum curvature posteroventrally. The cardinal area is flat, oblique triangular with a small and deep triangular resilifer below the umbo. The dentition is divided into two series separated by a narrow edentulous gap below the umbo. The straight anterior series is short, consisting of up to 3 parallel dorso-ventrally orientated hinge teeth, the posterior series of up to 6 teeth radiates with respect to a point situated anteroventrally of the umbo. The sculpture consists of prominent concentric ribs (6–7 per mm, 2 mm from umbo). Occasional weak radial ribs occur (2 per mm, 2 mm from umbo). Both the shell margin and the inside of the shell are smooth. The anterodorsal part overhangs and is not visible in lateral view. There is no anterior myophore.

Maximal dimensions: Height: 3.4 mm, length: 3.8 mm, width: 2.1 mm.

Shape indices: Fig. 14. The species shows isometric growth with respect to the height/length relationship and allometrical growth in the width/height ratio. In specimens 2.2. mm high the width constitutes 59 % of the height whereas in specimens with a height of 3.4 mm the same ratio is 68 %.

The obliquity index (i/j) shows a rapid increase in obliquity with growth, whereas the umbo-hinge index (D/E) and the inequilaterality index show a rather inconclusive pattern with respect to growth, probably owing to the small number of measurements.

Affinities: The affinity to *Limopsis ravni* n.sp. is discussed under that species. It differs from *Pectunculus höninghausii* with respect to sculpture as well as outline of the shell. The species is rather distinctive in having the overhanging interior side of the anterodorsal flank combined with total absence of an anterior myophore.

Material: 13 specimens from Stevns Klint comprising 10 from the type locality at Rødvig and 3 from Eskesti.

Limopsis misjae n.sp.
Figs. 15 & 16

Holotype: MGUH 13732, No. 2242 of the P. Gravesen collection. Height: 8.5 mm, length: 9.2 mm, width: 5.2 mm.

Type locality: Stevns Klint north of Kulsti.

Type stratum: The top hardground in the Upper Maastrichtian white chalk.

Diagnosis: An inequilateral smooth *Limopsis*, flat lenticular in shape, oblique ovate in outline, umbo moderate, projecting dorsally, in-

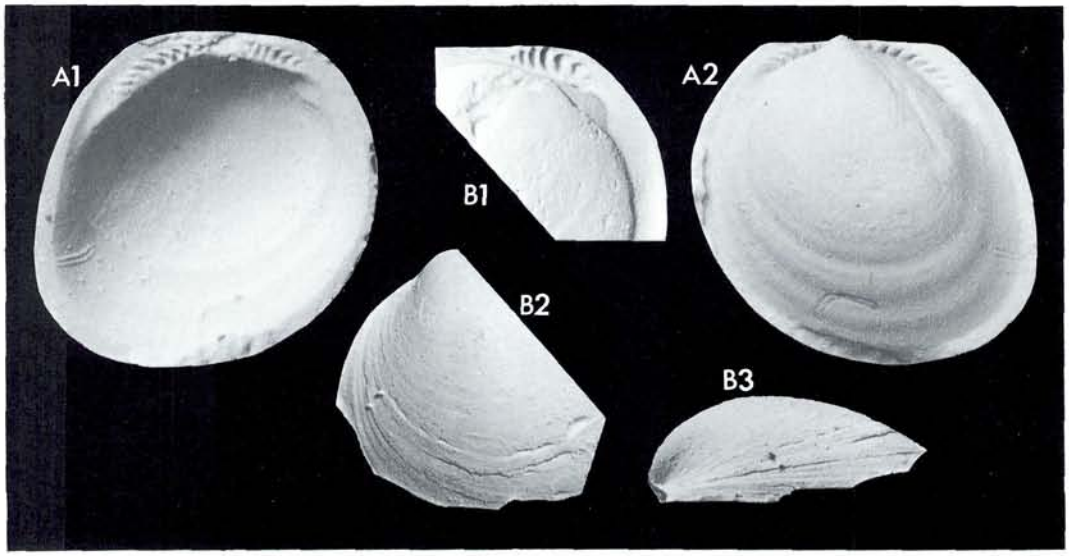

Fig. 15. Limopsis misjae *n.sp. A 1: Inside of a left valve. Latex cast of MGUH 13732. Holotype. × 5. A 2: Steinkern showing the inside of a left valve. Holotype. × 5. B 1: Anterior myophore of a left valve. Latex cast of MGUH 13733. × 4. B 2, B 3: Outer surface of a left valve seen in lateral and anterior view. Latex cast of MGUH 13733. × 4.*

side and margin of shell smooth, distinct anterior myophore.

Description: The shell is equivalve, flat lenticular with an oblique ovate outline, the posteroventral shell region somewhat enlarged. It is inequilateral, the umbo having a prosocline position. The umbo is of moderate size and projects dorsally. The hinge line is straight, the rest of the margin curves gently with a maximum of curvature posteroventrally. The cardinal area is flat, triangular with a resilifer below the umbo. The dentition is divided into two series by an edentulous gap; the anterior series consisting of up to 6 teeth, the posterior of up to 8. The two series form a curve, the

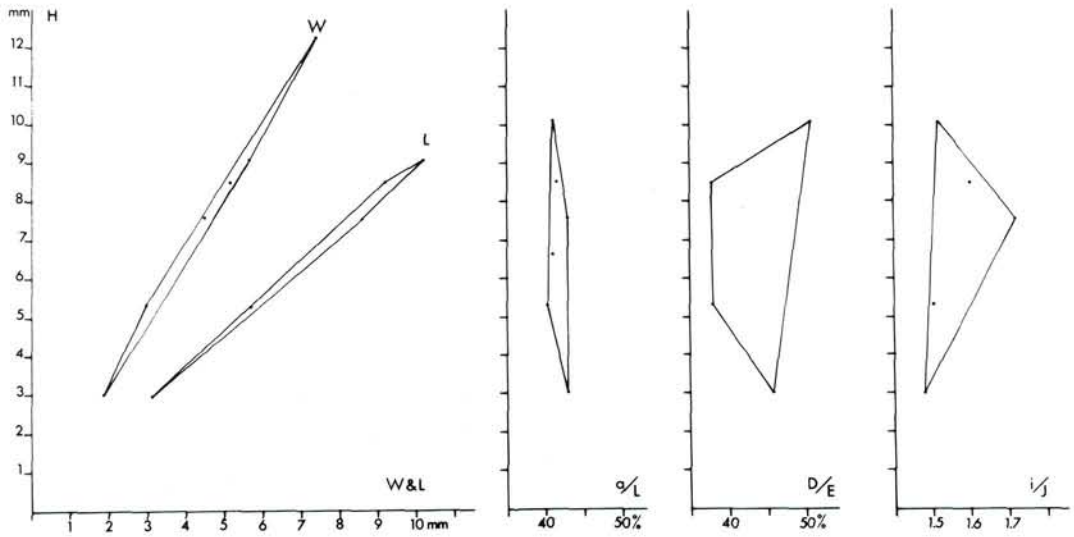

Fig. 16. Diagrams showing morphological parameters and indices of Limopsis misjae *n.sp. plotted against height. For explanation see text. See fig. 3 for abbreviations and definitions.*

teeth radiating with respect to a point anteroventral to the umbo.

The shell surface is smooth, with growth lines. Both the flat shell margin and the inside of the shell are smooth. There is a relatively large anterior myophore anteroventral to the hinge plate. The myophore is cut into the shell margin.

Maximal dimensions: Height: 10.1 mm (12.3 mm), length: 10.2 mm, width: 5.7 mm (7.4 mm). Numbers in parentheses are from an incomplete specimen.

Shape indices: Fig. 16. There is isometric growth both in the length/height relationship and the width/height ratio. The inequilaterality (a/L) seems to be fairly constant around a value of 42 %. The obliquity index (i/j) and the umbo-hinge index also seem to be fairly constant, but more measurements would be desirable.

Affinities: The species shows some resemblance to *Limopsis obliqua* (Defrance) (Cossmann & Pissarro 1903) from which it differs with respect to the shell sculpture, consisting of concentric ribs in the latter. The recent *Limopsis penelevis* Verco 1907 (Cotton 1961) and *Limopsis pelagica* Smith 1885 (Knudsen 1970) are both more oblique than *L. misjae* n.sp. *L. pelagica* also differs by having a radial component in the shell sculpture.

Material: 13 specimens from Stevns Klint, comprising 3 from north of Holtug chalk pit, 3 from Kulsti, 2 from north of Eskesti chalk pit, 2 from Rødvig and 3 from other parts of the cliff.

Limopsis helenae n.sp.
Fig. 17

Holotype: MGUH 13734. Height: 6.5 mm, length: 5.4 mm, width: 1.8 mm.

Type locality: Stevns Klint, immediately north of Holtug chalk pit.

Type stratum: The top hardground in the Upper Maastrichtian white chalk.

Diagnosis: A flat ovate *Limopsis*, with sculpture of prominent growth lines, umbo proso-

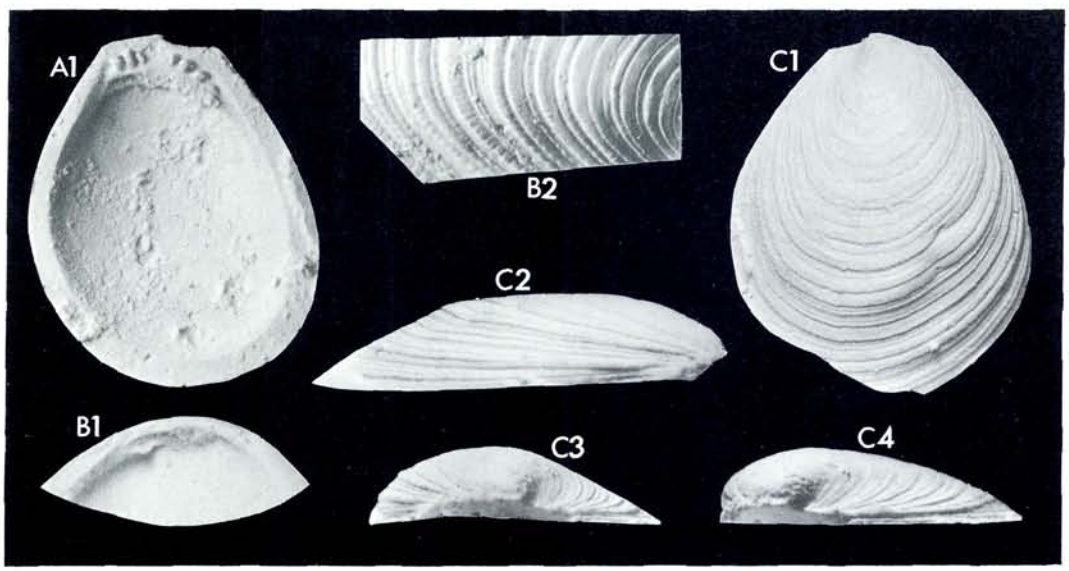

Fig. 17. Limopsis helenae *n.sp. A 1: Inside of a right valve. Latex cast of the holotype. MGUH 13734. × 7. B 1: Oblique view into the umbonal cavity of a left valve, showing the shelf-shaped myophore. Latex cast of MGUH 13735. × 5. B 2: Detail of outer surface showing shell sculpture of the posterior slope. Latex cast of MGUH 13735. × 6. C 1, C 2, C 3, C 4: Outer surface of a right valve seen in lateral, anterior and dorsal views, and parallel to the sole. Latex cast of MGUH 13736. × 6.*

gyrate, small, umbonal region flat, anterodorsal part of shell steeply inclined; anterior myophore spoon-shaped, forming a little shelf.

Description: The shell is equivalve, slightly prosocline, with a moderately enlarged posteroventral region. It is flat lenticular in shape with a steeply inclined anterodorsal part, forming a flat sole. The outline is ovate, narrowing dorsally. The umbonal region is flat with the little umbo projecting somewhat dorsally. The umbo is prosogyrate. The hinge line is relatively short and straight, and the rest of the margin curves gently with maximum curvature posteroventrally. The cardinal area is flat, triangular, with a concave dorso-posterior side. There is a relatively large resilifer below the umbo. The dentition is divided into two short series by a relatively large edentulous gap below the umbo. The anterior straight series consists of 3 parallel, slightly anteriorly inclined teeth, the posterior arched series consists of 4 teeth radiating with respect to a point immediately below the anteriormost tooth of that series. The sculpture is formed by distinct growth lines bordering flat shell sections descending away from the umbo as a staircase. Each "step" may undulate distally, especially in the posterior part of the shell. The shell margin as well as the inside of the shell are smooth. There is a distinct spoon-shaped anterior myophore projecting into the shell cavity as a little shelf.

Maximal dimensions: Height: 8.6 mm, length: 7.3 mm, width: 3.4 mm.

Shape indices are shown in table 1.

Table 1. Shape indices of *Limopsis helenae* n. sp.

	Height	Length	Width	a/L	i/j	D/E
13734	6.5 mm	5.4 mm	1.8 mm	41.5	1.4	41.4
13735	8.6 mm	7.3 mm	3.4 mm	(44.8)	(1.2)	(46.4)

Affinities: This species is well characterised by its general morphology combined with the peculiar myophore, which clearly distinguish it from other species.

Material: 3 specimens from Stevns Klint, north of Holtug chalk pit.

Acknowledgements. Erna Nordmann skillfully prepared the large number of latex casts. H. Egelund prepared the drawings and Annelise Dawes typed the manuscript. R. Bromley read the manuscript and improved the language. P. Gravesen, S. B. Andersen and the late A. Rosenkrantz kindly gave me access to their collections. The Carlsberg Foundation provided financial support for the study.

Dansk sammendrag

Beskrivelserne af 8 nye muslingearter fra det danske skrivekridt (Maastrichtien) af slægten *Limopsis* er de første i en planlagt række omfattende beskrivelser af ca. 40 nye arter af aragonitskallede muslinger fra hærdningshorisonten på Stevns Klint. Beskrivelserne er ledsaget af diagrammer, som kvantitativt fremstiller vigtige morfologiske karakterer til brug for den funktionsmorfologiske og økologiske tolkning (under forberedelse).

Note added in proof

A nineth species of *Limopsis* will be described in a later paper (Arcoida).

References

Cossmann, M. & Pissarro, G. 1903: Faune Éocénique du Cotentin. (Mollusques). *Bull. Soc. géol. Normandie* 2, 122 pp.

Cotton, B. C. 1961: *South Australian Mollusca. Pelecypoda.* 363 pp. Adelaide: Hawes.

Håkonsson, E., Bromley, R. & Perch-Nielsen, K. 1974: Maastrichtian chalk of north-west Europe – a pelagic shelf sediment. *Spec. Publs internat. Assoc. Sedimentology* 1, 211–233.

Knudsen, J. 1970: The systematics and biology of abyssal and hadal Bivalvia. *Galathea Rep.* 11, 241 pp.

Moore, R. C. 1969: *Treatise on Invertebrate Paleontology* N, 1. Mollusca 6, Bivalvia, 264–267.

Müller, J. 1847: *Monographie der Petrefakten der Aachener Kreideformation.* 87 pp. Bonn: Henry & Cohen.

Ravn, J. P. J. 1902: Molluskerne i Danmarks Kridtaflejringer I. Lamellibranchiater. *Kgl. dan. Vid. Selsk. Skr. 6, nat.mat. Afd.* 11 (2), 138 pp.

Rosenkrantz, A. 1924: Nye Iagttagelser over Cerithiumkalken i Stevns Klint med Bemærkninger om Grænsen mellem Kridt og Tertiær. *Meddr dansk geol. Foren.* 6, 28–31.

Rosenkrantz, A. 1939: Faunaen i Cerithiumkalken og det hærdnede Skrivekridt i Stevns Klint. *Meddr dansk geol. Foren.* 9, 509–514.

Rosenkrantz, A. 1966: Die Senon/Dan-Grenze in Dänemark. *Ber. deutsch. Ges. geol. Wiss. A. Geol. Paläont.* 11, 721–727.