7. APTYCHI (AMMONOIDEA) FROM THE LATE JURASSIC AND EARLY CRETACEOUS OF THE EASTERN ATLANTIC, DSDP SITE 367

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The exact stratigraphic range of numerous species and groups of aptychi is at present still unsatisfactorily known, and they are therefore often considered to be of subordinate value for stratigraphic correlations and for biostratigraphic subdivisions. This occurs because aptychi were generally preserved under special ecological circumstances, which were unfavorable for the preservation of age-indicative ammonite shells. Ideal, but rarely observable, conditions are found for instance in the Late Jurassic of Solnhofen in southern Germany, where numerous aptychi are preserved in their natural position within the body chambers of their corresponding ammonites. In the Alpine-Mediterranean facies province, however, where abundant aptychi are found, such favorable conditions did not exist. The water depth of the Tethyan Ocean during Late Jurassic and Early Cretaceous times remained mostly below the carbonate compensation depth (CCD), where ammonite shells are rarely found intact. Therefore the classification of aptychi has to be considered as tentative, and at present not adjustable to the taxonomy of the Ammonoidea. Due to the incomplete knowledge of their stratigraphic ranges, our ideas on the evolution of most of their morphological features must be considered provisional.

The core material obtained by the Deep Sea Drilling Project provides an exceptional opportunity to obtain data elucidating the problems connected with the stratigraphic succession of aptychi assemblages. This report indicates that a more reliable picture concerning the stratigraphic position of aptychi can be obtained. This could finally provide us with correlations based on the stratigraphic position of aptychi which might contribute towards this final aim, the recognition of a more reliable picture concerning the stratigraphic sequence of aptychi assemblages. This indicates that a more reliable picture concerning their stratigraphic ranges must be considered provisional.

The following discussions of all recognizable fragments have been arranged stratigraphically through the cores from the oldest to the youngest (Figure 1).

SAMPLE 367-36-2, 72-73 CM

The sediment is a dark, wine-red, argillaceous limestone comparable to the Rosso ad Aptychi facies of the Mediterranean province. It is composed of carbonates (64%) and of iron-rich clay material containing very small angular quartz grains and abundant mica flakes. Besides the Laevaptychus, numerous fragile plates of calcite derived probably from jaw parts of cephalopods occur. Several are reproduced on Plate 2, Figures 12, 13. The outlines of some of these plates resemble the problematica described from Site 99A, Leg 11, Sample 99A-14-2, 23-25 cm (Renz, 1974, p. 517, fig. 5 and pl. 2, fig. 1-4). Radiolario were not observed.

Laevaptychus mexicanus (Castillo y Aguilera)

(Plate 1, Figures 1a, b)

Aptychus mexicanus Cast. y Aguil., 1895, p. 45, pl. 22, fig. 8, Holotype.

Section 367-36-2, 72-73 cm is a well-preserved, isolated left valve. Its ventral half has been cut off when sawing the core. An attempted reconstruction of this compact form is based on the broad concentric growth segments exposed on the concave side. They follow the outline of the valve and are subdivided in narrowly spaced fine growth lines. The reconstruction gives a width-index (W:L) of about 0.82 against 0.86, and an apical angle of 105° against 90° on the Mexican specimen. Noteworthy are the pore openings on the
Figure 1. Stratigraphic distribution of aptychi in the late Jurassic and early Cretaceous from Leg 41; Site 367, DSDP (uncored intervals not indicated).
convex surface, which are very widely spaced and rounded to oval (Plate 1, Figure 1b).

The holotype is derived from the Late Jurassic of the Sierra Catorce in the Mexican State of San Luis Potosi. Unfortunately more detailed information regarding its stratigraphic position has not been given. Its position is 3.80 meters below the level of Core 367-35, which contains an assemblage of late Oxfordian forms, thus we assume an Oxfordian age for this specimen as most likely.

SECTIONS 367-35-4 AND 367-35-5

The three samples available consist of gray, rather soft calciulites, with carbonate contents varying between 42% and 47%. A significant change in facies must take place within an interval of 3.80 meters, separating the present samples from the preceding one, containing Laevaptychus mexicanus. Only 2.62 meters above the present interval of gray calciulites, Sample 35-2, 84-85 cm displays again the typical red facies, which here contains fragments of Inoceramus but no aptychi. Worth mentioning is a peculiar sedimentary feature found in Sample 35-5, 38-39 cm, which is provisionally discussed in the Appendix to this report (Plate 2, Figures 14-17).

Laevaptychus latus seriroporus Trauth

Aptychus latus Park., Favre, 1880, p. 45, pl. 3, fig. 12 (non fig. 11 = L. latus).
Laevaptychus latus var. serioporus, Trauth, 1931, p. 77, pl. 1, fig. 5.
Sample 367-35-5, 68-69 cm: The dorsal half of this left valve has been cut off by splitting the core. The important features are small, rounded to elongated pores arranged along concentric rows around the apex (Plate 1, Figure 2b). About five such rows of pores are recognizable on the convex surface. These pores are generally small and become larger and polygonal towards the lateral facet. The width-index (W:L), after an attempted reconstruction, amounts to 0.59, against 0.70 for a specimen figured by Favre (1880), derived from the Tithonian in the Canton Fribourg in Switzerland. Similar specimens have been described also from Solnhofen in southern Germany, where they occur in the Oxfordian as well as the Kimmeridgian (Malm zeta) (Trauth, 1931, p. 78).

Lamellaptychus cf. crassicauda (Oppel)

(Lamellaptychus cf. crassicauda (Oppel))

Lamellaptychus thoro (Oppel)

Aptychus crassicauda Quenst., 1846-1849, p. 183, pl. 13, fig. 4, cum synon.
Lamellaptychus thoro (Oppel), Trauth, 1938, pl. 1, fig. 9.
Lamellaptychus thoro (Oppel), Gasiroworski, 1962, pl. 4, fig. 9.
Lamellaptychus thoro (Oppel), Renz, 1974, p. 515, pl. 2, fig. 5.
Sample 367-35-5, 141-142 cm and 367-35-4, 147-148 cm: Abundant, fragile, juvenile valves occur which are difficult to free from the sediment. The best preserved examples were obtained from Samples 367-35-4, 147-148 cm, where most of the specimens seen belong to this group. Very similar, if not identical forms from Sample 99A-14-2, 23-24 cm, situated north of the Bahamas, have been assigned to this form. The laminae exactly follow the lateral and ventral margins of the valve, and they meet the symphysis with acute angles ranging between 60° and 70°. The width-index, according to Trauth (p. 184), varies between 0.40 and 0.70 compared with 0.53 to 0.56 for the present specimens.

L. thoro is known from the Oxfordian and Kimmeridgian in southwestern Germany (Malm alfa to zeta). Further it has been mentioned by Trauth from the Tithonian near Vienna, and by Gasiorowski (1962) from the Carpathians in the Oxfordian within the horizons II and III (not VI as erroneously mentioned by Renz, 1974).

Lamellaptychus ? lithographicus (Oppel)

(Plate 1, Figures 7a,b)

Aptychus von Ammonites lithographicus Oppel, 1863, p. 249, pl. 68, fig. 2, 3.
Aptychus sp. ind., Favre, 1876, p. 63, pl. 6, fig. 12.
Lamellaptychus lithographicus (Oppel), Trauth, 1938, p. 181, pl. 13, fig. 1, cum synon.
Lamellaptychus lithographicus (Oppel), Gasiroworski, 1962, pl. 4, fig. 10.
Sample 367-35-4, 147-148 cm: One specimen which has been cut diagonally when splitting the core might be assigned to this species. A reconstruction of the valve has been attempted, but the evidence is insufficient. The lamellae parallel the lateral margin and seem to meet the symphysis with acute angles. The width-index of L. lithographicus varies according to Trauth (p. 182) between 0.40 and 0.50, compared with 0.41 for the present reconstruction.

In southern France (Dép. Ardèche) L. lithographicus occurs in the Oxfordian (Dumortier and Cotteau, 1871) and in Solnhofen in the Malm zeta (Kimmeridgian) (Steinmann, 1907). From the Carpathians, Gasiroworski mentioned it from the Oxfordian, together with L. thoro (horizons II and III).

Lamellaptychus cf. crassicauda (Quenstedt)

(Plate 1, Figures 11, 12)

Aptychus crassicauda Quenst., 1846-1849, p. 314, pl. 22, fig. 25a.
Aptychus lamellosus crassicauda Quenst., 1858, p. 596, pl. 77, fig. 9.
Aptychus lamellosus crassicauda Quenst., 1885, p. 590, pl. 46, fig. 18.
Lamellaptychus crassicauda (Quenst.), Trauth, 1938, p. 162, pl. 11, fig. 16-19.
Lamellaptychus crassicauda (Quenst.), Gasiroworski, 1962, pl. 4, fig. 3.
Sample 367-35-5, 38-39 cm: This species is represented by three juvenile specimens. Their specific feature is a conspicuous thickening of the ventral termination of the valve. This accumulation of calcite is associated with a partial disappearance of the lamellae over this region. The thickening at this juvenile stage can be followed weakly along the symphysis margin towards the apex. The lamellae are parallel to the lateral margin, as well as to the growth segments visible on the concave surface, and they meet the symphysis at 65°. The width-index attains 0.56.

This form has been described from the Oxfordian in France (Dép. Ardèche) by Sayn and Roman (1930, p. 244), from Switzerland (Badener-Schichten, lower
From Core 35, Section 5 some additional, undetermined, poorly preserved specimens may be mentioned. If better material appears during future drilling, these might gain importance.

**Lamellaptychus sp.**  
(Plate 1, Figure 14)

Sample 367-35-5, 38-39 cm. This specimen is distinguished by a considerable thickening of the circum-apical region caused by deposition of a layer of calcium carbonate covering the lamellae similar to that on Punctaptychus.

**Lamellaptychus sp.**  
(Plate 1, Figure 13)

Sample 367-35-5, 38-39 cm: This thin and very fragile juvenile valve resembles Lamellaptychus hauffianus (Oppel) (1863, p. 211, pl. 56, fig. 3). The typical thickening along the external margin, however, is not developed on the present specimen, perhaps due to its juvenile stage.

**CONCLUSIONS**

The following aptychi could be isolated from Core 367-35:

<table>
<thead>
<tr>
<th>Sample</th>
<th>Lower Bound</th>
<th>Upper Bound</th>
<th>Aptychus Name</th>
<th>Plate</th>
<th>Figures</th>
</tr>
</thead>
<tbody>
<tr>
<td>35-4, 147-148 cm</td>
<td>Lamellaptychus cf. thoro</td>
<td>1, Figures 3, 4</td>
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<td></td>
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<tr>
<td>35-4, 147-148 cm</td>
<td>Lamellaptychus ? lithographicus</td>
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<tr>
<td>35-5, 141-142 cm</td>
<td>Lamellaptychus cf. thoro</td>
<td>1, Figures 5, 6</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>35-5, 38-39 cm</td>
<td>Lamellaptychus crassicauda</td>
<td>1, Figures 11, 12</td>
<td></td>
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<td></td>
</tr>
<tr>
<td>35-5, 38-39 cm</td>
<td>Lamellaptychus sparcilamellosus</td>
<td>1, Figure 9</td>
<td></td>
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<tr>
<td>35-5, 38-39 cm</td>
<td>Lamellaptychus murocostatus</td>
<td>1, Figure 10</td>
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<tr>
<td>35-5, 38-39 cm</td>
<td>Lamellaptychus sp.</td>
<td>1, Figure 13</td>
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<td></td>
</tr>
<tr>
<td>35-5, 38-39 cm</td>
<td>Lamellaptychus sp.</td>
<td>1, Figure 14</td>
<td></td>
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<td></td>
</tr>
<tr>
<td>35-5, 68-69 cm</td>
<td>Lævaptychus latus seriporus</td>
<td>1, Figures 2a, b</td>
<td></td>
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</tbody>
</table>

Most of the species observed within the 1.45-meter interval are reported from the Oxfordian as well as from the Kimmeridgian. In the Carpathians, Gasiorowski mentions them from horizons III and IV, corresponding to the late Oxfordian. Based on the informations available so far, we suggest an Oxfordian age for this assemblage.

**SECTION 367-34-4**

Three samples have been collected over an interval of 22 cm. The sediment features are characteristic for the Rosso ad Aptici occurring in Italy and other places in the tethyan Upper Jurassic. Where no Radiolaria occur, the sediment consists of carbonates (50%-65%) and red clay. If Radiolaria are abundant the carbonate content decreases to 30%. The aptychi-fauna is
extraordinarily diversified and quite distinct from that of the underlying samples.

**Punctapychus punctatus (Voltz)**  
(Plate 1, Figure 16)

Punctapychus punctatus (Voltz), Trauth, 1935, p. 315, pl. 12, fig. 1-6, cum synon.
Punctapychus punctatus (Voltz), Renz, 1972, p. 612, pl. 1, fig. 5a-c, cum synon.

Sample 367-34-4, 64-65 cm and 34-4, 43-44 cm: Both valves were cut diagonally when sawing the core, such that only the apical regions are available. As far as we know P. punctatus is restricted to the Alpine-Mediterranean region, where it is widely distributed. It is a characteristic fossil indicating a Late Jurassic age.

**Granulaptychus planulati (Quenstedt)**  
(Plate 1, Figures 15a, b)

Aptychus planulati Quenstedt, 1852, p. 382, pl. 30, fig. 10
Aptychus von *Am. ulmensis* Oppel, 1863, p. 261, pl. 74, fig. 3.
Aptychus planulati (spinulatus) Quenstedt, 1887-1888, p. 1080, pl. 26, fig. 2.

Granulaptychus planulati (Quenst.), Trauth, 1937, p. 154, pl. 11, fig. 5-11, cum synon.

Sample 367-34-4, 44-45 cm: For an accurate age determination this uncommon specimen is significant. It is embedded in a brick-red, hard limestone (carbonates 63%). When examining the core, broken off spines appeared as shown in Plate 1, Figure 15b. The cleaning of the valve from the tough sediment was only partly successful, but nevertheless the characteristic features are recognizable. The ventral margin of this right valve is preserved. The surface shows concentric ribs from which numerous, irregularly spaced knobs and spines project. Those spines are of variable size and arranged approximately along two rows. Their tops are obtuse and well rounded.

Granulaptychus planulati has repeatedly been observed within the body chambers of Perisphinctidae, especially of *Litharcoceras ulmensis* (Oppel), the type fossil for the *ulmensis* Zone (Trauth, 1937, pl. 11, fig. 5). Those finds are from the Malm zeta in Württemberg, as well as Solnhofen in Bavaria. The importance of this fossil for a subdivision of the Jurassic interval of Site 367 is obvious. It indicates a level, which according to our present knowledge, permits a reasonable correlation with the Jurassic section of southern Germany.

The only Granulaptychus known from the Mediterranean region is *G. trescorrensis* Trauth (1937, p. 158, pl. 11, fig. 13-16) described by Meneghini (1881, p. 211, 240, pl. 31) from a red marly Late Jurassic limestone in the Lombardian Alps in the vicinity of Trescorre.

**Lamellaptychus pleiadensis Trauth**  
(Plate 1, Figure 17)

Aptychus sp. ind, Favre, 1877, p. 70, pl. 9, fig. 2.
Lamellaptychus pleiadensis Trauth, 1938, p. 164, pl. 11, fig. 22.

Lamellaptychus pleiadensis Trauth, Gasiorowski, 1962, pl. 5, fig. 14.
Samples 367-34-4, 43-44 and 34-4, 44-45 cm: The important feature of these two right valves is the parallel course of the lamellae with the lateral margin and a clearly developed narrow symphysal plate at right angles to the lamellae.

*L. pleiadensis* is known from the lower part of the Malm delta (*acanthicum*—Schichten, early Kimmeridgian) from Pliades in the Canton Fribourg in Switzerland. Gasiorowski (1962, pl. 5) quotes this species from horizons IV and V, corresponding to the early Kimmeridgian.

**Laevaptychus latus vermiporus Trauth**  
(Plate 1, Figures 18a, b)

Laevaptychus latus Parkinson var. vermiporus Trauth, 1931, p. 81.

Sample 367-34-4, 44-45 cm: The pores on the convex surface of this fragment display a vermiciform and ramified pattern as reproduced on Plate 1, Figure 18b. After a tentative reconstruction of the valve, a width-index of 0.74 is obtained, which is within the range for *Laevaptychus* latus (0.67-0.80).

This form, described but never illustrated by Trauth, is derived, like *Granulaptychus planulati*, from the Malm zeta of Solnhofen (middle Kimmeridgian).

**CONCLUSIONS**

The four species recovered from Core 34 belong to different groups and indicate that a very rich ammonite assemblage must have lived during deposition of this interval.

<table>
<thead>
<tr>
<th>34-4, 43-44 cm</th>
<th>Punctapychus punctatus</th>
<th>Plate 1, Figure 16</th>
</tr>
</thead>
<tbody>
<tr>
<td>34-4, 43-44 cm</td>
<td>Lamellaptychus pleiadensis</td>
<td>Plate 1, Figures 15a, b</td>
</tr>
<tr>
<td>34-4, 44-45 cm</td>
<td>Granulaptychus planulati</td>
<td>Plate 1, Figures 18a, b</td>
</tr>
<tr>
<td>34-4, 44-45 cm</td>
<td>Lamellaptychus pleiadensis</td>
<td>Plate 1, Figures 18a, b</td>
</tr>
<tr>
<td>34-4, 44-45 cm</td>
<td>Laevapt. latus vermiporus</td>
<td>Plate 1, Figures 18a, b</td>
</tr>
<tr>
<td>34-4, 64-65 cm</td>
<td>Punctapychus punctatus</td>
<td>Plate 1, Figure 16</td>
</tr>
</tbody>
</table>

There are 9.83 meters of sediment separating this fauna from the late Oxfordian assemblage previously discussed. An age determination is based mainly on Granulaptychus planulati and Lamellaptychus pleiadensis, which are both reported from the early Kimmeridgian. The Oxfordian-Kimmeridgian boundary is perhaps somewhere between Sample 367-35-2, 84-85 cm (fragments of *Inoceramus* in a brick-red matrix without aptychi) and Sample 367-34-4, 64-65 cm.

**SECTIONS 367-31-1 AND 367-31-2; SAMPLE 367-30, CC**

The aptychi assemblage of Core 367-31 is separated from the preceding fauna of late Kimmeridgian age by 67 meters of sediment. Only one sample of gray
calcituitate without aptychi (Sample 367-33-2, 93-94 cm) is present from this interval. The lithology changes from the Rosso ad Aptici facies into a gray, fine-grained calcituitate interspersed with abundant thin laminae and flakes of a white apparently powdery calcite. Its carbonate content varies between 48% and 52%.

Most probably this sediment sequence represents the Tithonian. A correlation with Cores 33 and 34 from Site 105 in the northwestern Atlantic is suggested by the presence of typical Lamellaptychi such as L. beyrichi, L. lamellosus, and L. rectecostatus (Renz, 1972, pl. 2, 3.).

**Lamellaptychus aplanatus (Gilliéron)**
(Plate 1, Figures 25a,b)

Aptychus aplanatus Gilliéron, 1873, p. 238, pl. 10, fig. 4.

Lamellaptychus aplanatus (Gill.), Trauth, 1938, p. 171, pl. 12, fig. 8-10.

Lamellaptychus aplanatus (Gill.), Gasiorowski, 1962, pl. 6, fig. 9; pl. 7, fig. 8.

Sample 367-31-2, 2-3 cm and 31-2, 4-5 cm (identical, slightly compressed specimen): On the better preserved upper surface (Figure 25a) the concave side of the left valve overlaps onto the impression of the convex side of the right valve. We observe a flat, broad, arch-like elevation (keel), beginning near the apex and following the line of the symphysis as far as the middle of the valve, from where it flattens out. Its slope towards the symphysis is considerably steeper than towards the lateral margin. The lamellae are parallel to the lateral and ventral margins and develop a very slight inflection over this elevation. They meet the symphysal edge at an acute angle (around 60°). The width-index amounts to 0.53, and thus lies well within the limits for this form (0.44-0.58, Trauth, p. 171).

L. aplanatus has been recorded from the Neocomian of the Swiss Alps, and from Bavaria and Austria (Tithonian-Neocomian). From the Carpathians, Gasiorowski records it from horizons VI and VII, which corresponds to the Tithonian-Berriasian.

**Lamellaptychus theodosia rectangulus Trauth**
(Plate 1, Figures 20a, b)

Aptychus beyrichi Gemmellaro, 1868-1876, p. 25, pl. 3, fig. 18.

Lamellaptychus theodosia rectangulus Trauth, 1938, p. 187, pl. 13, fig. 10.

Lamellaptychus theodosia rectangulus Trauth, Gasiorowski, 1962, pl. 6, fig. 42.

Samples 367-31-1, 94-95 cm; 31-2, 2-3 cm; and 367-30, CC: The course of the lamellae is parallel to the lateral and ventral margins, and they meet the symphysis at right angles. On the larger right valve of the largest pair, even a slight retroverse bending of the lamellae can be observed. The measurements are: apical angle about 102°, width-index of the left valve 0.52, of the right valve 0.57, juvenile stage 0.53, which compares well with the data obtained by Trauth, ranging between 0.44 and 0.60. Such individual variations of the two valves are noticeable.

This form has been reported from the late Tithonian and the Berriasian in the Austrian Alps (Trauth, p. 187), and from the Tithonian of Sicily. Gasiorowski mentions this species from the Carpathians in horizon VI (Tithonian).

**Lamellaptychus noricus (Winkler)**
(Plate 1, Figure 22)

Aptychus noricus Winkler, 1868, p. 27, pl. 4, fig. 14.

Lamellaptychus noricus (Winkler), Trauth, 1938, p. 189, pl. 13, fig. 14, 15, cum synon.

Lamellaptychus noricus (Winkler) Gasiorowski, 1962, pl. 7, fig. 12.

Sample 367-31-1, 94-95 cm: This form differs from L. theodosia and L. aplanatus by the presence of a broad elevation, crossing diagonally over the valve from the apex towards the ventral margin. The course of the rather flat lying lamellae is parallel to the lateral and ventral margins. They meet the symphysal edge with angles averaging 80°. The lamellae cross over the elevation without inflections. The width-index of 0.64 lies slightly above the upper level, as fixed by Trauth (0.40-0.61).

L. noricus is widely distributed and has been noted in the Neocomian of the Alps from France eastwards to Austria. From the Carpathians its presence has been recorded by Gasiorowski in horizon VII corresponding to the Berriasian.

**Lamellaptychus indet. 1**
(Plate 1, Figures 23a, b)

Sample 367-31-2, 2-3 cm: So far this form has not been described in the literature. Apart from the destroyed, extremely thin-shelled apical region, all characteristic features are well exposed on this pair of valves. It is a slender form, having a width-index of only 0.50. The apical angle is about 100°. On the convex side a pronounced keel crosses diagonally over the middle sector of the valve and meets the symphysis below the apex. It breaks abruptly against the steep lateral facet. This implies that the last four lamellae on the ventral end of the valve terminate against the steep lateral facet. On the dorsal half of the valve a shallow depression is developed, which causes a distinct indentation along the lateral margin. Over the keel no noticeable inflection of the lamellae occurs. The symphysis is met by the lamellae at right angles (drawing Plate 1, Figure 23b).

**Annotation:** A closely related adult and best preserved specimen has been recovered from Sample 43-387-49-4, 104-105 cm from the western Bermuda Rise. It has been named Lamellaptychus bermudensis.

**Lamellaptychus indet. 2**
(Plate 1, Figures 24a, c)

Section 367-31-2, 4-5 cm: Only the cast of the convex side and a few fragments of the valve are preserved. A reconstruction has been attempted (Plate 1, Figure 24b). The outstanding feature is a very pronounced keel, which begins near the symphysis just above the apex, and diagonally crosses the valve to reach the lateral margin just below its turning point into the ventral margin. Towards the symphysis the keel flattens gently; towards the lateral margin, however, it falls off vertically and seems even to be slightly overturned at its base. Along the vertical slope the lamellae form two
acute-angled bends, which gradually turn into a normal inflection towards the apex where the keel gradually gets less steep. On the flat slope towards the symphysial edge the lamellae display broad curves, which slightly recurve in the direction of the apex.

Sample 367-30, CC consists of a hard, unbedded, tough, white limestone, containing ammonites but few aptychi. In a thin section abundant calcified Radiolaria can be recognized. The ammonites recovered are poorly preserved and specifically indeterminable. They belong to the Families Phylloceratidae (1 specimen) and Haploceratidae (6 specimens). The Phylloceratid (Plate 2, Figure 9) shows a fine striation without constrictions visible, and it might represent a Hypophylloceras. The Haploceratid (Plate 2, Figure 8) could be a Haploceras. One of the two aptychi found is a small Lamellaptychus theodosia (Deshayes) (Plate 1, Figure 19)

Aptychus theodosia Deshayes in Verneuil et Deshayes, 1838, p. 32, pl. 6, fig. 6.
Aptychus von Am. asterianus, Gilliérón, 1873, p. 229, 240, pl. 10, fig. 1.
Lamellaptychus theodosia (Desh.), Trauth, 1938, p. 185, fig. 8, 9.
Lamellaptychus theodosia (Desh.), Gasiorowski, 1962, pl. 6, fig. 41-43.

Sample 367-30, CC: This form is poorly represented by a juvenile pair of valves. The lamellae follow the lateral and ventral margins and cross straight over the broadly arched convex surface. After reconstruction of the missing ventral end, a width-index of 0.55 results. According to Trauth the index varies between 0.40 and 0.56 for this species.

L. theodosia has been recorded in the upper Malm and the Berriasian in the Alpine-Mediterranean province, especially in France, Switzerland, Austria, and the Krimean Peninsula. From the Carpathians Gasiorowski listed it from the Tithonian (horizon VI), together with the “variety” rectangulus.

CONCLUSIONS

The interval reaching a thickness of only 60 cm is conspicuously rich in aptychi as six species could be recovered.

<table>
<thead>
<tr>
<th>Sample</th>
<th>Aptychus</th>
<th>Lamellaptychus</th>
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<tbody>
<tr>
<td>30, CC</td>
<td>L. theodosia</td>
<td>rectangulus</td>
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<tr>
<td>30, CC</td>
<td>L. cf. theodosia</td>
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<tr>
<td>31-1, 94-95 cm</td>
<td>L. noricus</td>
<td>Plate 1, Figure 22</td>
</tr>
<tr>
<td>31-1, 94-95 cm</td>
<td>L. theodosia</td>
<td>rectangulus</td>
</tr>
<tr>
<td>31-2, 2-3 cm</td>
<td>L. Indet. 1</td>
<td>Plate 1, Figures 23a, b</td>
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<tr>
<td>31-2, 2-3 cm</td>
<td>L. theodosia</td>
<td>rectangulus</td>
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<td>L. Indet. 2</td>
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<td>31-2, 4-5 cm</td>
<td>L. aplanatus</td>
<td>Plate 1, Figures 25a, b</td>
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</tbody>
</table>

During this period the initial stages towards a retroverse lamellae-pattern began to develop. Based on the available material, we place this assemblage within the transition zone from the Tithonian to the Berriasian.

SECTIONS 367-28-1 AND 367-28-2

This interval is separated from the preceding samples, which we assumed to be within the transition zone from Late Jurassic to Early Cretaceous, by a sediment column of 79.83 meters. The present samples consist of gray calcilutite with similar flaks and patches of white powdery calcite as observed on samples from Core 367-31. The carbonate-content of some samples examined remains above 50%. The residue is a dark gray clay, rich in small pyrite octahedra.

Lamellaptychus didayi (Coquand) (Plate 1, Figures 26a-c)

Aptychus didayi Coquand, 1841, p. 389, pl. 1, fig. 10.
Trigonellites didayi Coq., Ooster, 1857, p. 28, pl. 7, fig. 8.
Aptychus didayi Coq., Pictet and Loriol, 1858, p. 46, pl. 10, fig. 1.
Aptychus didayi Coq., Winkler, 1868, p. 28, pl. 4, fig. 16.
Lamellaptychus didayi (Coqu.), Trauth, 1938, p. 198, pl. 14, fig. 3, 4.
Lamellaptychus didayi (Coqu.), Gasiorowski, 1962, pl. 8, fig. 9.

Sample 367-28-2, 66-67 cm: The ventral half of the two valves has been cut off when splitting the core. The left valve overlaps on the symphysal half of the right valve (Figure 26a), and it shows the beginning of a broad and flat elevation. On its steeper slope towards the symphysis we observe the beginning of the retroverse turning of the lamellae (Figure 26c). A weak inflection of the lamellae is present over the elevation.

According to the literature L. didayi is a widely distributed species (Trauth, 1938, p. 200). It has been reported within the Alpine-Mediterranean province, mainly from Spain (Killian, 1907-1913), southern France, and the Swiss Alps (Ooster, 1857), the Bavarian Alps, Austria, and Italy. From the Carpathians, Gasiorowski mentions this form from horizon VIII representing the Valanginian and Hauterivian. Lacoste (1934, p. 272) noted its presence in Morocco.

Lamellaptychus aff. herthae (Winkler) (Plate 1, Figures 31-33)

Aptychus herthae Winkler, 1868, p. 28, pl. 4, fig. 12.
Lamellaptychus herthae (Winkler), Trauth, 1938, p. 178, pl. 12, fig. 22.
Lamellaptychus herthae (Winkler), Gasiorowski, 1962, pl. 7, fig. 2.

Samples 367-28-2, 66-67 cm and 28-2, 60-61 cm: Four identical small specimens could be obtained from both samples, indicating an abundant occurrence at this level. Outstanding is a keel with steep flanks on both sides, extending diagonally over the valve from the apex to the lateral margin. On the dorsal half of the valve a very shallow depression is developed, which implies a slight concave indentation of the lateral margin. The steep lateral facet flattens out abruptly at its base, filling the space resulting from the indentation.
(pointed area on Plate 1, Figure 32b). Over the keel the lamellae form acute inflections and meet the symphysal edge at angles of about 70°, compared with 40°-60° on a typical L. herthae.

This species is known from Tithonian-Neocomian limestones in the Austrian and Bavarian Alps (Trauth, p. 179). In the Carpathians it occurs in the Berriasian (horizon VII of Gasiorowski).

**Lamellaptychus seranonis (Coquand)**
(Plate 1, Figures 28, 29)
Aptychus seranonis Coquand, 1841, p. 390, pl. 9, fig. 13.
Aptychus seranonis Coqu., Pictet and Loriol, 1858, p. 48, pl. 11, fig. 1, 2.
Lamellaptychus seranonis (Coqu.), Trauth, 1938, p. 193, pl. 13, fig. 27-29.
Lamellaptychus seranonis (Coqu.), Gasiorowski, 1962, pl. 8, fig. 13, 14.
Lamellaptychus seranonis (Coqu.), Renz, 1972, p. 615, pl. 3, fig. 4, 5.

Samples 367-28-1, 58-59 cm and 28-1, 60-61 cm:
These two pairs of valves are comparable with specimens figured by Pictet and Loriol (1858, p. 48) from the Neocomian of the French Alps (Voirons) and reproduced by Trauth (pl. 13, fig. 27, 28). They also are largely identical with L. seranonis described from the western North Atlantic (Renz, 1972, p. 615, fig. 4, 5). The width-index amounts to 0.52 for the larger specimen and 0.50 for the smaller one. The respective apical angles are about 90° to 100°. A very shallow depression on the marginal flank of the keel is recognizable.

**Lamellaptychus ? seranonis (Coquand)**
(Plate 1, Figure 30)
Sample 367-28-1, 60-61 cm: Whether this juvenile pair of valves should be grouped with L. seranonis is questionable. Based on its slender outline (width-index 0.36) it probably belonged to a quite different ammonite species. A peculiar feature is the elevation which covers the dorsal half of the valve. It rises abruptly along a line crossing the valve diagonally. The laminae at that size run straight over this elevation. Due to the juvenile stage of this specimen a new name is not introduced.

**CONCLUSIONS**
For a reliable age determination this small fauna is evidently not sufficient. The presence of L. didayi and representatives of the seranonis group suggests an Early Cretaceous age, probably Valanginian.

**SECTION 367-27-3 AND SECTIONS 367-26-1 TO 367-26-4**
This interval reaches a thickness of 25 meters, and it is separated from the previous samples by a gap of 23 meters. The sediment is a similar gray, rather uniform calcilutite (carbonate content 40%-48%) as composing the samples from Core 28 below. A fish-vertebra (diameter 4 mm) is preserved in Sample 367-27-3, 94-95 cm.

**Group of Lamellaptychus angulocostatus (Peters)**
The Lamellaptychi observed within this interval are all distinguished by a retroverse lamellae pattern as characteristic for L. angulocostatus. Nevertheless they display such considerable variations that we may assume that different ammonite species are involved.

**Lamellaptychus angulocostatus (Peters)**
Lamellaptychus angulocostatus (Peters), Trauth, 1938, p. 204, pl. 14, fig. 12, 13.
Lamellaptychus angulocostatus (Peters), Gasiorowski, 1962, pl. 8, fig. 1, 4.

**SAMPLE 367-27-3, 94-95 CM**
(Plate 1, Figure 34)
The pronounced elevation covering the entire dorsal half of the valve shows a shallow depression towards the lateral margin, which causes a slight indentation, as on L. seranonis. The lamellae cross straight over this elevation. On the left valve they display a typical "angulocostatus" pattern, whereas on the right valve they rather seem to resemble L. seranonis. The outlines of the two valves are noticeably different. The width-index of the right valve is 0.49 against 0.40 for the left one.

**SAMPLE 367-27-3, 25-26 CM**
(Plate 1, Figure 35)
The lamellae pattern is typical for L. angulocostatus. The two valves, as far as preserved are very even and the lamellae widely spaced.

**SAMPLE 367-26-3, 58-59 CM**
(Plate 2, Figure 2)
Aptychus angulocostatus Peters, Pictet and Loriol, 1858, pl. 10, fig. 3., proposed lectotype.

**SAMPLE 367-26-4, 58-59 CM**
(Plate 2, Figure 1)
Aptychus angulocostatus Peters, Pictet and Loriol, 1858, p. 46, pl. 10, fig. 8a-d.
This specimen differs from the proposed lectotype by its broad elevation following the symphysis from the apex to the ventral margin. The retroverse turning of the lamellae occurs along the steep slope following the symphysis. This form is best comparable with Pictefs cristobalensis. This form is best comparable with Pictefs cristobalensis (O'Connell) from the Vinales Limestone in Cuba might be suggested (Imlay, 1942, pi. 11, fig. 2).

A juvenile pair of valves appeared within this sample (Plate 2, Figure 4). Its width-index reaches 0.54, and the acute angled lamellae are well developed at that size (compare Picte and Loriol, 1858, pi. 10, fig. 11, 12).

**Lamellaptychus angulocostatus fractocostatus** Trauth (Plate 2, Figures 5-7)

Lamellaptychus angulocostatus var. fractocostata Trauth, 1938, p. 208, pl. 14, fig. 17.

Lamellaptychus angulocostatus fractocostatus, Gasiorowski, 1962, pl. 8, fig. 2.

Samples 367-26-1, 69-70 cm and 26-1, 41 cm: A well-preserved pair of valves and a left valve representing the juvenile stage are available. The acute angled lamellae turn rounded towards the ventral end of the valve. An approach to the variety cristobalensis (O'Connell) from the Viñales Limestone in Cuba might be suggested (Imlay, 1942, pi. 11, fig. 2).

Similar valves have been described from the northwestern Atlantic as L. atlanticus Hennig (Renz, 1972, p. 617, pl. 4, fig. 2a, b, 3, 4, Leg 11, Site 105).

Lamellaptychus angulocostatus fractocostatus is 0.50, compared with 0.43 on the specimens from the western Atlantic as L. atlanticus Hennig (Renz, 1972, p. 617, pi. 4, fig. 2a, b, 3, 4, Leg 11, Site 105).

A juvenile pair of valves appeared within this sample (Plate 2, Figure 4). Its width-index reaches 0.54, and the acute angled lamellae are well developed at that size (compare Picte and Loriol, 1858, pi. 10, fig. 11, 12).

**L. angulocostatus aff. cristobalensis** (O'Connell) (Plate 2, Figure 3)

Lamellaptychus angulocostatus cristobalensis (O'Connell), Imlay, 1942, p. 1460, pi. 11, fig. 2.

The ventral part of a large left valve is preserved. The acute angled lamellae turn rounded towards the ventral end of the valve. An approach to the variety cristobalensis (O'Connell) from the Viñales Limestone in Cuba might be suggested (Imlay, 1942, pi. 11, fig. 2).

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A peculiar sedimentary feature occurs in Sample 367-35-5, 38-39 cm. Scanning electron micrographs illustrate this phenomenon, which has possibly also been seen by other observers. An alternation of very thin layers of calcilutite with equally thin layers of calcite is visible (pl. 2, fig. 14). The calcite layers (or plates) display a characteristic polygonal pattern, best comparable to desiccation or shrinkage cracks developing on drying clay surfaces (pl. 2, fig. 15). The upper surface of the polygonal calcite bodies is irregularly deeply dentated (pl. 2, fig. 16). This dentation suggests that diagenetic processes, perhaps some form of solution, may be responsible for this surface appearance. We observe that the tops of the dentation are projected over the rim of the coccoliths, what suggests that the deposition of the coccoliths on the calcite surface occurred before the formation of the dentation. An impression of a Coccolith on the calcite surface (right half of the photograph fig. 16) also points into this direction. On the other hand a biogenetic origin cannot be fully excluded, as intact coccoliths unaffected by diagenetic solution, were deposited on the surface of the calcite polygons (pl. 2 fig. 17).

APPENDIX

A. O. Renz

Figure 1  
Sample 36-2, 72-73 cm, Oxfordian.  
1a. Laevaptychus mexicanus (Castillo y Aquilera). 1.5×.  
1b. Convex surface showing widely spaced pores. 6×.

Figures 2-14  
Core 35, Sections 4, 5, late Oxfordian.  
2a. Section 5, 68-69 cm: Laevaptychus latus seriporus Trauth. 1.5×.  
2b. Convex surface showing the arrangement of the pores. 6×.  
5. Section 5, 141-142 cm: Lamellaptychus cf. thoro (Oppel), convex side. 6×.  
6. Section 5, 141-142 cm: Lamellaptychus cf. thoro (Oppel), convex side. 6×.  
7a. Section 4, 147-148 cm: Lamellaptychus ? lithographicus (Oppel), convex side. 3×.  
7b. Section 4, 147-148 cm: Lamellaptychus ? lithographicus (Oppel), concave side, impression. 3×.

Figures 15-18  
Core 34, Section 4, Kimmeridgian.  
15a. Section 4, 44-45 cm: Granulaptychus planulati (Quenstedt). 1.5×.  
15b. Impression of the convex side showing broken off spines. 3×.  
17. Section 4, 43-44 cm: Lamellaptychus pleiadespis Trauth. 3×.  
18a. Section 4, 44-45 cm: Laevaptychus latus vermiporus Trauth. 1.5×.  
18b. Convex surface with vermiform pores. 6×.

Figures 19-25  
Core 31, Sections 1, 2, late Tithonian to Berriasian.  
20a. Section 1, 94-95 cm: Lamellaptychus theodosia rectangulus Trauth. 3×.  
20b. Section 1, 94-95 cm: Lamellaptychus theodosia rectangulus, juvenile stage. 3×.  
21. Section 2, 2-3 cm: Lamellaptychus theodosia rectangulus Trauth. 3×.  
22. Section 1, 94-95 cm: Lamellaptychus noricus (Winkler). 3×.  
23a. Section 2, 2-3 cm: Lamellaptychus indet. 1. 3×.  
23b. Reconstructed left valve. 3×.  
24a. Section 2, 4-5 cm: Lamellaptychus indet. 2, impression. 1.5×.  
24b. Reconstructed right valve. 1.5×.  
24c. Fragment of the right valve. 1.5×.  
25a. Section 2, 2-3 cm: Lamellaptychus aplanatus (Gilliéron). 1.5×.  
25b. Section 2, 4-5 cm: Lamellaptychus aplanatus (Gilliéron), opposite side. 1.5×.

Figures 26-33  
Core 28, Sections 1, 2, Valanginian.  
26a. Section 2, 66-67 cm: Lamellaptychus didayi (Coquand), convex surface. 1.5×.  
26b. Impression. 1.5×.  
26c. Reconstruction of the left valve. 1.5×.  
27a. Section 1, 60-61 cm: Lamellaptychus aff. seranonis (Coquand), impression. 1.5×.  
27b. Fragments of both valves. 1.5×.  
28. Section 1, 58-59 cm: Lamellaptychus seranonis (Coquand). 3×.  
29. Section 1, 60-61 cm: Lamellaptychus seranonis (Coquand). 3×.  
30. Section 1, 60-61 cm: Lamellaptychus ? seranonis (Coquand). 3×.  
31. Section 2, 66-67 cm: Lamellaptychus aff. herthae Winkler. 3×.  
32a. Section 1, 60-61 cm: Lamellaptychus aff. herthae (Winkler). 3×.  
32b. Tentative reconstruction. 3×.  

Figures 34, 35  
Core 27, Section 3, Hauterivian.  
34. Section 3, 94-95 cm: Lamellaptychus angulocostatus (Peters). 3×.  
PLATE 2

Figures 1-7  Core 26, Sections 1-4, Hauterivian.
1. Section 4, 58-59 cm: Lamellaptychus angulocostatus (Peters). 1.5×.
2. Section 3, 58-59 cm: Lamellaptychus angulocostatus (Peters). 1.5×.
5. Section 1, 69-70 cm: Lamellaptychus angulocostatus fractocostatus Trauth. 3×.
6. Section 1, 69-70 cm: Lamellaptychus angulocostatus fractocostatus Trauth. 1.5×.
7. Section 1, 41 cm: Lamellaptychus angulocostatus fractocostatus Trauth. 1.5×.

Figures 8, 9  Cephalopoda.
8. Sample 30, CC: Haploceras sp. 1.5×.

Figures 10-13  Rhyncholites.
10. Sample 35, CC: Gonatocheilus sp. 3×.
11. Sample 35, CC: Rhyneholutes sp.
12. 13. Sample 36-2, 72-73 cm: Problematic jaw parts of cephalopods. 6×.

Figures 14-17  Sedimentary features observed in Sample 35-5, 38-39 cm.
14. Small layers of white calcite displaying a polygonal texture. 120×.
15. Calcite plates alternating successively with very thin micritic sediment layers. 240×.
16. The surface of the individual calcite polygons is deeply dentated. On the right half of the photograph the impression of a coccolith is visible. 600×.
17. Coccolith deposited on the surface of calcite polygons. The calcite overlaps on the rim of a coccolith. 2400×.