Paleontological analysis

may be of interest. Stylolites are most prominent in the slumped section near the base, which may have been a "pièce de résistance". In the thin- and even bedded Maiolica above the basal slumped section stylolites are usually small. Mostly they seem to occur along roughly conjugated and not very regular shear planes at high angles to the bedding. Offsets of one set by the other are not common. Calcite steps (LAUBSCHER 1979), often steeply dipping, are rather frequent and so are calcite-filled tension cracks. Visible dislocations of entire strata are absent or minimal. Degree of organic metamorphism had not advanced very far, the Staplin index of sporomorphs being estimated at around 2 (pers. communication P. A. Hochuli). Obviously, such a level was attained towards the end of the depositional history and ramained practically unchanged during the subsequent Alpine compressional deformation.

Folding, faulting and thrusting affected the Mesozoic rocks of the Monte Generoso–Breggia sector during the Tertiary. The resulting tectonics is in line with the regional compressional tectonic style of the Lombardy Alps which also included the northern Po valley, as demonstrated by ERRICO et al. (1980). The course of events can tentatively be reconstructed in the following manner: During Oligocene/early Miocene: A hinge line formed, spearating the rising Generoso area from the subsiding Po valley to the south, which was being filled with clastics derived from the Alps. During the interval spanning middle Miocene to earliest Pliocene, folding and thrusting occurred, and in consequence of these movements the hinge line was accentuated.

Towards the end of this interval, major thrusting ceased, and erosion and peneplanation affected the Po valley. The hinge zone remained active and a canyon was cut into the folded Cretaceous of the Breggia gorge which was filled with coarse fluviatile clastics (Pontegana Conglomerate) thought to be of early Pliocene (BERNOULLI 1966) or latest Miocene (LAUBSCHER & BERNOULLI 1980) age. Subsequently, marine Pliocene transgressed over the peneplained Po valley, reaching the southern tip of Switzerland at Balerna west of the border town of Chiasso. Both the Pontegana Conglomerate and the marine Pliocene remained in their depositional, nearly horizontal, position.

Tertiary uplift at the site of the Maiolica section of the Breggia gorge is estimated to have amounted to between 2000 and 3000 m, a figure suggested by the estimated combined thickness of the Scaglia, the Flysch, and the Oligocene–early Miocene clastics.

D. Paleontological analysis

Fig. 1, 2; Pl. 1–5

Class Cephalopoda LEACH 1817
Order Ammonoidea ZITTEL 1884
Aptychus MEYER 1829

a) General remarks

Little attention has generally been paid to the occurrence of aptychi, in spite of their value for stratigraphic zonations and correlations with holes in the Atlantic, mainly in sediments deposited below the Aragonite Compensation Depth.

Descriptions of aptychi are stratigraphically arranged, from the top of the Rosso ad Aptici Formation until the contact of the Maiolica Formation against the Scaglia Variegata Formation (Fig. 2).

Many "specific" taxons of aptychi, so far, were established on morphological criteria without considering their biostratigraphic succession. The repetition of morphological features on forms from different levels led to the establishment of "subspecies" based on forms of quite distinct ages. The consideration of the stratigraphic succession of aptychi is thus indispensable to achieve a sound base for taxonomy. Consequently samples of aptychi from the Maiolica Formation deposited in previous collections, without a reference regarding their position within the formation, are not considered.

The aptychi figured by TRAUTH (1938) are described by him in great detail, and we refer to the respective descriptions.

For complete lists of publications dealing with aptychi we also refer to TRAUTH (1938), GASIOROWSKI (1963) and to DURAND DELGA & GASIOROWSKI (1970).

The interpretation and representation of aptychi on Plates 1–5 has been adapted to SCHINDEWOLF (1958, Pl. 1–9, p. 1–46).

An alternative view regarding the function of aptychi has been brought forward by LEHMANN (1972, 1976, p. 93) and MORTON (1981) who define aptychi as lower jaws of ammonites. Recently TANABE & FUKUDA (1983, p. 249) described a lower jaw of a *Gaudryceras,* composed of chitin, from the upper Santonian in Hokkaido, Japan.

The limits of stage boundaries in the Lower Cretaceous are based on ammonite assemblages. As aptychi represent parts of the ammonite conch, the distinct breaks visible on the distribution chart of aptychi (Fig. 1) should be reflected also on respective distribution charts for the ammonites.

The position of fossils within the Maiolica section (Fig. 1) is indicated by a first number (horizontal distance from the base of the Maiolica to its top) followed by a second one in brackets corresponding to the respective levels on the columnar section (Fig. 2).

b) Systematic descriptions of aptychi from the Rosso ad Aptici Formation (late Tithonian) and the Maiolica Formation (Berriasian–Barremian)

Late Tithonian (Fig. 1)

A remarkably rich aptychi assemblage was obtained from the upper surface of the top-layer of the Rosso ad Aptici Formation. This layer, about 10 to 20 cm thick, consists of a light grey-greenish, calcareous matrix with streaks of nodular grey chert. The majority of the components composing the sediment are Radiolaria still silicified. The surface of the layer is irregularly ondulated and light brownish weathered. This layer representing an outstanding dipslope is followed immediately by white Maiolica limestone, contorted by subaquatic sliding events. The basal layers of the Maiolica contain *Calpionella alpina* LORENZ (WEISSERT 1979, p. 39, and REMANE 1983, p. 564).

The age of the aptychi assemblage recovered from the surface of this top layer of the Rosso ad Aptici is late Tithonian. From deeper in the section of the Rosso ad Aptici large specimens of *Laevaptychus latus* (PARKINSON) and *Laevaptychus obliquus* (QUENSTEDT) were observed (J30901, coll. P. O. Baumgartner; J30902, D. Bernoulli).

Laevaptychus longus (MEYER) of *Physodoceras altense* (D'ORBIGNY)
Pl. 1, Fig. 1

1829 *Aptychus laevis longus* MEYER, Pl. 59, Fig. 6, p. 127–131.
1931 *Laevaptychus longus* (MEYER), TRAUTH, Fig. B, 4–7, p. 40.
1958 *Laevaptychus longus* (MEYER), SCHINDEWOLF, Pl. 1, Fig. 1a–b, Pl. 8, Fig. 5.

Occurrence: 0 m, J30728, surface of top-layer of the Rosso ad Aptici Formation.
Age: Late Tithonian.
Remarks: A single, rather thin-shelled valve with a width index of 0.70, can be compared with *Laevaptychus longus*. SCHINDEWOLF (1958, Pl. 1, Fig. 1a–b) figures *L. longus* covering the aperture of a *Physodoceras* cf. *altense* (D'ORBIGNY) from the Malm at the Burgberg of Onstmettingen.

Laevaptychus latissimus TRAUTH
Pl. 1, Fig. 2

1858 *Aptychus laevis* von *Ammonites inflatus* QUENSTEDT, 1858, p. 797, Pl. 98, Fig. 30.
1931 *Laevaptychus latissimus* TRAUTH, p. 105, compare Fig. C, 13, p. 131.

Occurrence: 0 m, J30909, surface of top-layer of the Rosso ad Aptici Formation.
Age: Late Tithonian.
Remarks: The form is distinguished from *Laevaptychus longus* by its large width-length index of about 1.

Laevaptychus longus seriporus TRAUTH
Pl. 1, Fig. 3

1931 *Laevaptychus longus* var. *seripora* TRAUTH, p. 49.

Occurrence: 0 m, J30729, surface of top-layer of the Rosso ad Aptici Formation.
Age: Late Tithonian.
Remarks: A juvenile specimen appears to be identical with forms described by TRAUTH (1931), characterized by concentrically arranged rows of pores around the apex.

Laevaptychus latus vermiporus TRAUTH
Pl. 1, Fig. 4

1931 *Laevaptychus latus vermiporus* TRAUTH, p. 81.
1977 *Laevaptychus latus vermiporus* TRAUTH, RENZ, Pl. 1, Fig. 18a–b, p. 503 (Cap Verde Basin).

Occurrence: 0 m, J30730, surface of top-layer of the Rosso ad Aptici Formation.
Age: Late Tithonian.
Remarks: The pores arranged parallel to the surface of the valve appear as meandring rows.

Lamellaptychus beyrichi (OPPEL)
Pl. 1, Fig. 5, 6

1865 *Aptychus Beyrichi* OPPEL, p. 547.
1873 *Aptychus Beyrichi* OPPEL, GILLIÉRON, Pl. 9, Fig. 9a, b, p. 237.

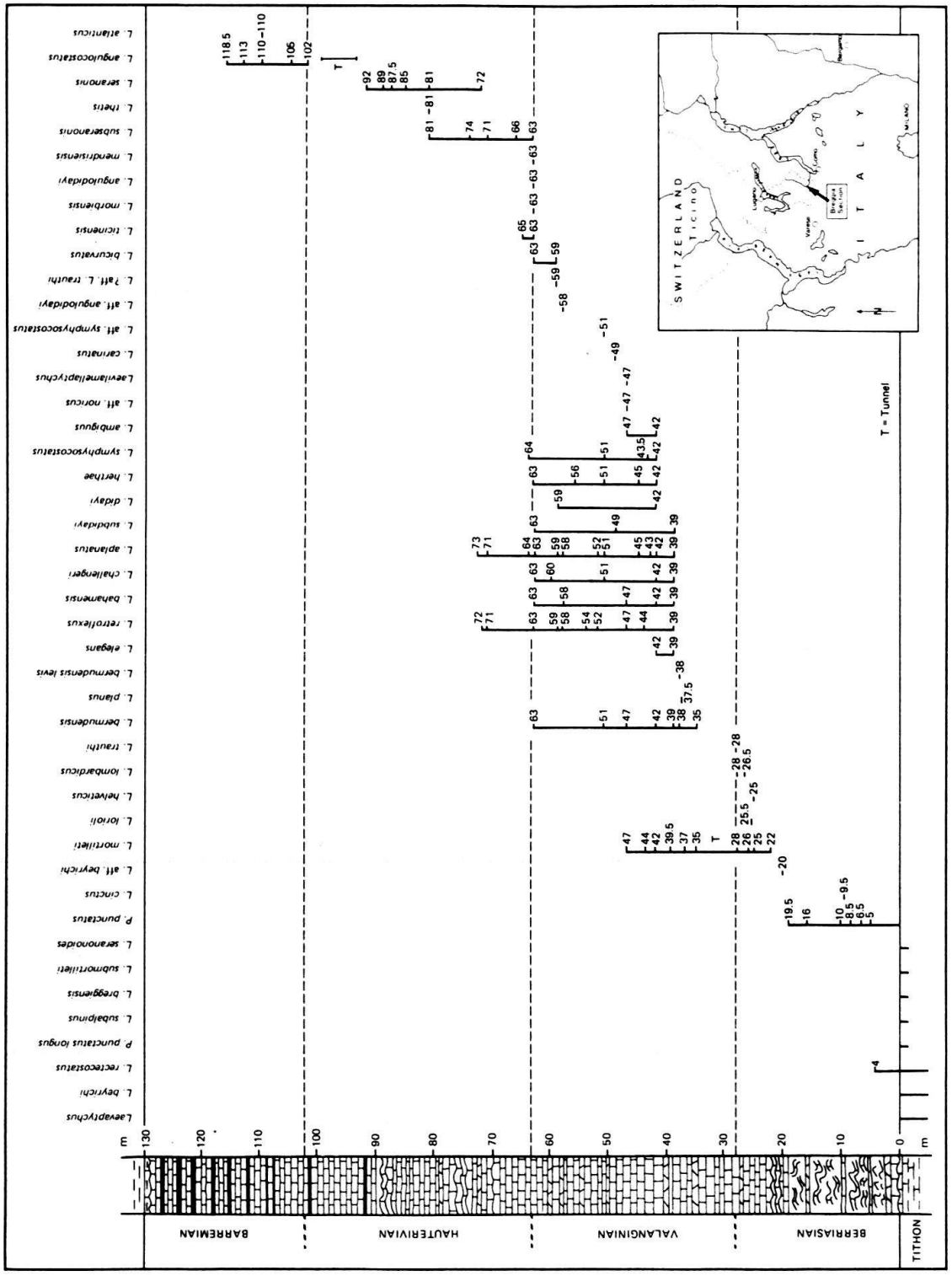

Fig. 2. Distribution chart of aptychi in the Maiolica Formation (Berriasian–Barremian).

1938 *Lamellaptychus beyrichi* (OPPEL), TRAUTH, Pl. 10, Fig. 5, p. 134.
1972 *Lamellaptychus beyrichi* (OPPEL), RENZ, Pl. 2, Fig. 3, p. 614 (Hatteras Abyssal Plain).
1983 *Lamellaptychus beyrichi* (OPPEL), RENZ, Pl. 1, Fig. 19, p. 640 (Blake-Bahama Basin).

Occurrence: 1.5 m below top of Rosso ad Aptici Formation, J30732; surface of top-layer of the Rosso ad Aptici Formation, J30908.
Age: Late Tithonian to Berriasian.
Remarks: *L. beyrichi* is widely known in the Tithonian throughout the Tethian realm. The figured specimens represent *L. beyrichi* typically, as described by GILLIÉRON (1873). RETOWSKI (1891, p. 220) shows a *Lamellaptychus*, referred to as *L. beyrichi*, covering the aperture of a *Haploceras elimatum* (OPPEL). Owing to poor preservation this connection remains doubtful.

Lamellaptychus rectecostatus (PETERS)
Pl. 1, Fig. 7

1854 *Aptychus rectecostatus* PETERS, p. 442.
1938 *Lamellaptychus rectecostatus* (PETERS), TRAUTH, p. 131, Pl. 10, Fig. 1–3.
1970 *Lamellaptychus rectecostatus* (PETERS), DURAND-DELGA & GASIOROWSKI, p. 769.

Occurrence: 0 m, J30733, surface of top-layer of the Rosso ad Aptici Formation and within the lower 4 m of the Maiolica Formation (fragment J30877, not figured).
Age: Late Tithonian to Berriasian.
Remarks: Transitions from *L. beyrichi* towards *L. rectecostatus* occur in the Rosso ad Aptici Formation.

In the Carpathians and the western Mediterranean, according to DURAND-DELGA & GASIOROWSKI (1970, p. 769), *L. rectecostatus* is associated with ammonites indicating a Berriasian age.

Punctaptychus punctatus longus TRAUTH
Pl. 1, Fig. 8

1875 *Aptychus punctatus* var. très allongée, FAVRE, Pl. 7, Fig. 5, p. 49.
1935 *Punctaptychus punctatus* var. *longa* TRAUTH, Pl. 12, Fig. 7, p. 320.
1965 *Punctaptychus punctatus* TRAUTH, POZZI, Pl. 86, Fig. 12, p. 872.

Occurrence: 0 m, J30734, surface of top-layer of the Rosso ad Aptici Formation.
Age: Late Tithonian.
Remarks: The figured left valve closely resembles the holotype, established by FAVRE (1875) from the Upper Jurassic of the Montagne des Voirons, Haute Savoie.

Lamellaptychus subalpinus (SCHAFHÄUTL)
Pl. 1, Fig. 9

1853 *Aptychus subalpinus* SCHAFHÄUTL, Pl. 6, Fig. 8, p. 405, holotype.
1857 *Trigonellites curvatus* OOSTER, Pl. 5, Fig. 13, p. 20.
1938 *Lamellaptychus beyrichi* var. *subalpina* (SCHAFHÄUTL), TRAUTH, Pl. 10, Fig. 15, p. 140, refigured from OOSTER (1857).

Occurrence: 0 m, J30735, surface of top-layer of the Rosso ad Aptici Formation.
Age: Late Tithonian.
Remarks: On the dorsal half of the specimen the lamellae curve parallel to the lateral margin of the valve and then progress straight, converging towards its ventral end. This form seems to be related closely to *L. breggiensis,* on which, however, the lamellae disperse along the ventral facet.

Lamellaptychus breggiensis new name
Pl. 1, Fig. 10–11

1857 *Trigonellites Studeri* OOSTER, Pl. 7, Fig. 6, p. 26, holotype.
1938 *Lamellaptychus mortilleti* (PICTET & LORIOL), TRAUTH, Pl. 10, Fig. 29, p. 145 (refigured holotype).

Occurrence: 0 m, J30736, Pl. 1, Fig. 10.
0 m, J30737, Pl. 1, Fig. 11, surface of top-layer of the Rosso ad Aptici Formation.
Age: Late Tithonian.
Description: L. breggiensis is distinguished by its flat and broad valve, only slightly elevated along its apical-diagonal axis. The width-length index attains 0.70, against 0.55 to 0.57 for *L. mortilleti* from the Breggia section. The juvenile lamellae follow and end along the symphyseal margin in acute angles. Later the lamellae augment in strength getting broader and converging towards the ventral end of the valve. The last marginal lamellae terminate along the ventral facet.

The holotype of *L. breggiensis* (OOSTER 1857, Pl. 7, Fig. 6) has been interpreted by TRAUTH (1938, p. 145) as *Lamellaptychus mortilleti* (PICTET et LORIOL). Owing to its low stratigraphic position below *Lamellaptychus mortilleti* and its occurrence with Tithonian aptychi a separation from the *mortilleti* group is here proposed.

Lamellaptychus form indet.
Pl. 1, Fig. 13, 15

cf. 1857 *Trigonellites curvatus* GIEBEL, OOSTER, Pl. 5, Fig. 11, 16, p. 20.

Occurrence: 0 m, J30738, Pl. 1, Fig. 13.
0 m, J30739, Pl. 1, Fig. 15, surface of top-layer of the Rosso ad Aptici Formation.
Age: Late Tithonian.
Remarks: The present two specimens might best be interpreted as intermediate between *L. beyrichi* and *L. submortilleti.* The straight juvenile lamellae follow the symphyseal margin and end along the ventral facet near the ventral end of the valve (Pl. 1, Fig. 15), as it is typical for *L. beyrichi.* The adult broader and wider spaced lamellae, turn towards the end of the valve before reaching its ventral facet. In this they differ from *L. beyrichi.*

On the juvenile stage of the valve reproduced on Plate 1, Figure 13, the lamellae meet the symphyseal margin acute-angled. The bending of the adult lamellae towards the ventral end of the valve, before reaching the ventral facet, is less distinct than on the specimen on Plate 1, Figure 15. It cannot be excluded that such forms are related to

L. seranonoides on which the juvenile straight lamellae are covered by the adult ones turning right-angled against the symphyseal margin.

It seems premature to propose a new name for the present form until additional material from other sections becomes available.

Lamellaptychus submortilleti TRAUTH
Pl. 1, Fig. 12, 14

1938 *Lamellaptychus sub-mortilleti* TRAUTH, Pl. 10, Fig. 23, 25, p. 143.
1979a not *Lamellaptychus submortilleti,* RENZ, Pl. 1, Fig. 23–26, p. 594 (Western Bermuda Rise).

Occurrence: 0 m, J30740, Pl. 1, Fig. 12.
0 m, J30741, Pl. 1, Fig. 14, surface of top-layer of the Rosso ad Aptici Formation.
Age: Late Tithonian.
Remarks: The form is characterized by its elongated moderately arched valve, without an apical-ventral elevation and a lateral depression. On the juvenile stage (Pl. 1, Fig. 12) the lamellae follow the symphyseal margin until meeting it acute-angled. With proceeding growth the lamellae get broader what is connected with a distinct bending approaching the margin (Pl. 1, Fig. 14).

The name *"submortilleti"* introduced by TRAUTH (1938) for such forms seems not appropriate. A connection with true *L. mortilleti* from higher in the section is, so far, not indicated. The introduction of new names for the present varieties also remains questionable, as long as their stratigraphic range is not verified along other sections.

The considerably jounger specimens from the Western Bermuda Rise, compared with *L. submortilleti* by RENZ (1979a), are now better interpreted as varieties of typical *L. mortiletti.*

Lamellaptychus seranonoides TRAUTH
Pl. 1, Fig. 16

1938 *Lamellaptychus beyrichi* var. *seranonoides* TRAUTH, Pl. 14, Fig. 2, p. 198.

Occurrence: 0 m, J30742, surface of top-layer of the Rosso ad Aptici Formation.
Age: Late Tithonian.
Remarks: The right valve derives from a matrix composed nearly entirely of Radiolaria, still silicified. The pattern of the lamellae on the juvenile stage closely approaches that on *Lamellaptychus* form indet. shown on Pl. 1, Fig. 13, 15. The beginning of the adult stage is indicated by a widening of the lamellae. An about right-angled turn of the first two broader adult lamellae towards the symphyseal margin covers the ends of the previous thinner juvenile lamellae which followed parallel to the symphyseal margin. Thereafter the lamellae again normalize ending along the ventral facet.

Berriasian (Fig. 1)

The lower 34 m (28 m) of the Maiolica Formation consist of massively layered, hard, dense, splintery, white limestone interbedded by irregular layers, lenses and nodules of

light grey to light brown chert. The layers within this interval are partly contorted, due to subaquatic sliding (WEISSERT 1979, p. 42). Aptychi, the only macrofossils, are scattered and difficult to be extracted from the hard rock. *Punctaptychus*, by far, is the most abundant form.

The existence of a sedimentary gap between the Rosso ad Aptici and the Maiolica Formation is possible, but it cannot be assertained by the fossils available.

Punctaptychus punctatus VOLTZ
Pl. 1, Fig. 17–19

1935 *Punctaptychus punctatus* (VOLTZ), TRAUTH, Pl. 12, Fig. 1–6, p. 315.
1962 *Punctaptychus punctatus* (VOLTZ), GASIOROWSKI, Pl. 6.
1972 *Punctaptychus punctatus* (VOLTZ), RENZ, Pl. 1, Fig. 5a–b, p. 612 (Hatteras Abyssal Plain).

Occurrence: 6.5 m (5.5 m), J30743.
8.5 m (6.5 m), J30744.
10 m (8.5 m), J30745, Pl. 1, Fig. 17.
10 m (8.5 m), J30895, Pl. 1, Fig. 18.
12 m (10 m), J30746.
20 m (16 m), J30747.
23.5 m (19.5 m) J30748, Pl. 1, Fig. 19, above base of the Maiolica Formation.
Age: Berriasian.
Remarks: *Punctaptychus* widely mentioned from the Tithonian and Berriasian in the mediterranean region, is not known from the Kimmeridgian in the Jura mountains. According to our present observations in the Breggia section, *Punctaptychus punctatus* seems to be restricted within the lower Maiolica Formation, considered to represent the Berriasian. From older levels of the Rosso ad Aptici Formation in Tuscany other forms of *Punctaptychus (P. triangularis)* are present (KÄLIN et al. 1979, Fig. 11a).

Punctaptychus cf. *cinctus* TRAUTH
Pl. 1, Fig. 20

1935 *Punctaptychus cinctus* TRAUTH, Pl. 12, Fig. 11, 12, p. 326.

Occurrence: 11.5 m (9.5 m), J30749, above base of the Maiolica Formation.
Age: Berriasian.
Remarks: The large, highly arched valve, partly affected by erosion, shows the characteristic curving of the adult lamellae towards the symphyseal margin, meeting it right-angled.

Lamellaptychus ? aff. *beyrichi* (OPPEL)
Pl. 1, Fig. 21

1938 *Lamellaptychus beyrichi* var *moravica* (BLASCHKE), TRAUTH, Pl. 10, Fig. 13, p. 139.

Occurrence: 24 m (20 m), MB11, J30750, above base of the Maiolica Formation.
Age: Most likely late Berriasian.
Remarks: GASIOROWSKY (1962, p. 63) already noticed that *Aptychus moravicus* BLASCHKE (1911, Pl. 1, Fig. 5a–b, p. 152) has nothing in common with *L. beyrichi*.

In the Breggia section the present specimen represents the latest occurrence of a valve displaying features comparable with *L. beyrichi*, from considerably deeper in the section within the Tithonian. It might have evolved from typical *L. beyrichi* from which it differs by its thinner and closer placed lamellae. The specimen could be distinguished by a new name, once its high position in the section will be confirmed at other localities.

Group of *Lamellaptychus mortilleti* (PICTET & LORIOL)

All specimens grouped with *L. mortiletti*, collected between 27 m (22 m) to 57 m (47 m) within the Maiolica section are distinguished by a pronounced apical-diagonal elevation, followed by a lateral depression of the valve. Forms without such a depression, referred to by TRAUTH (1938, Pl. 10, Fig. 23–25, p. 143) as *L. submortilleti* were so far not obtained from the Maiolica Formation. *L. submortilleti* seems to be restricted to the upper layer of the Rosso ad Aptici Formation. No relation of *L. submortilleti* with the true *L. mortiletti* higher in the sections is, so far, indicated in the Breggia section.

Lamellaptychus mortilleti (PICTET & LORIOL)
Pl. 1, Fig. 22–26, Pl. 2, Fig. 1–5

1858 *Aptychus Mortilleti* PICTET & LORIOL, Pl. 11, Fig. 9a–d, p. 50.
1938 *Lamellaptychus mortilleti* (PICTET & LORIOL), TRAUTH, Pl. 10, Fig. 30 only, p. 145.
1978 *Lamellaptychus mortilleti* (PICTET & LORIOL), RENZ, Pl. 1, Fig. 3a–b, p. 903 (Blake-Bahama Basin).
1979a *Lamellaptychus mortilleti* (PICTET & LORIOL), RENZ, Pl. 1, Fig. 16–22, p. 594 (Western Bermuda Rise).

Lectotype: PICTET & LORIOL, 1858, Pl. 11, Fig. 9b, refigured by RENZ (1979a) (Leg 43, Pl. 1, Fig. 16, Western Bermuda Rise).
Occurrence: 27 m (22 m), MB14, J30751, Pl. 1, Fig. 23.
30 m (25 m), MB200, J30752, Pl. 1, Fig. 22.
31 m (26 m), J30753a, Pl. 1, Fig. 25.
31 m (26 m), J30753b, Pl. 1, Fig. 26.
34 m (28 m), J30754, Pl. 2, Fig. 1.
34 m (28 m), J30895, Pl. 2, Fig. 2.
44 m (35 m), J30755.
45 m (37 m), J30756, Pl. 2, Fig. 3.
47.5 m (39.5 m), J30757, Pl. 1, Fig. 24.
50 m (42 m), J30758, Pl. 2, Fig. 5.
53 m (44 m), MB204, J30759, Pl. 2, Fig. 4.
57 m (47 m), MB205, J30760.
Age: Late Berriasian–Valanginian.
Remarks: A typical *L. mortilleti*, comparable with the lectotype, has not been figured by TRAUTH (1938). The specimen figured by TRAUTH on Plate 10, Figure 30, represents a broad variety with narrowly placed, fine lamellae. A comparable specimen (Pl. 2, Fig. 3) comes from 45 m (37 m) in the Breggia section.

Additional material from other sections will certainly enable us to establish a more detailed taxonomic subdivision of this variable, long-ranging group than it is possible with the material in hand.

Lamellaptychus lorioli RENZ
Pl. 2, Fig. 6

1867 *Aptychus Seranonis* COQUAND, PICTET, F.J., Pl. 28, Fig. 9b, p. 123, holotype from Berrias, Dépt. Ardèche.
1938 *Lamellaptychus seranonis* (COQUAND), TRAUTH, Pl. 13, Fig. 29, p. 193, refigured holotype.
1979 *Lamellaptychus lorioli* RENZ, Pl. 1, Fig. 5a–b, p. 593 (Western Bermuda Rise).
1978 *Lamellaptychus lorioli* RENZ, Pl. 1, Fig. 6a–b, p. 904 (Blake-Bahama Basin).

Occurrence: 30 m (25 m), J30761, above base of the Maiolica Formation.
Age: Late Berriasian to early Valanginian.
Remarks: The present specimen is distinguished from *L. lorioli* from the Western Bermuda Rise by its stronger pronounced rounded apical-diagonal elevation, followed by a flatter lateral depression of the valve. A pecularity of *L. lorioli* seems to be the simultaneous growth of about three lamellae exposed at the ventral end of the valve.

The considerable interval separating *L. lorioli* from younger forms with analogous retroverse curving lamellae patterns, as *L. retroflexus* from 47 m (39 m) to 87 m (72 m) and *L. subseranonis* from 75 m (63 m) to 97 m (81 m), makes a relation of *L. lorioli* towards the *L. seranonis* group unlikely. On the other hand *L. lorioli* could be interpreted as a successor of *L. plicatus* PILLET (1886, Pl. 2, Fig. 6, p. 16) from the Kimmeridgian near Chambéry in the French Alps.

Lamellaptychus helveticus new form
Pl. 2, Fig. 7–9

Occurrence: Holotype, 30 m (25 m), J30762, Pl. 2, Fig. 7, adult stage.
Paratype 1, 30 m (25 m), J30763, Pl. 2, Fig. 8, median stage.
Paratype 2, 30 m (25 m), J30764, Pl. 2, Fig. 9, juvenile stage, above base of the Maiolica Formation.
Age: Late Berriasian to early Valanginian.
Description: The thin-shelled valve representing the holotype shows a broad, flatly-rounded apical-diagonal elevation. Its steeper lateral slope implies a slight lateral depression of the valve, connected with weakly inflected lamellae. The different ways of approach of the lamellae against the symphyseal margin on the juvenile and adult stages seem to be characteristic for this form. On the juvenile stage (Pl. 2, Fig. 9) the lamellae, before nearing the symphyseal margin, bend sharp-angled ventrally, meeting the margin in acute angles. Here the pattern closely resembles to *L. ticinensis* from 38 m higher in the section, at 75 m (63 m). On the median stage (Pl. 2, Fig. 8) the lamellae approach the symphyseal margin right-angled. On the holotype (Pl. 2, Fig. 7, adult stage) a retroverse turning of the last lamellae, comparable to those on *L. retroflexus* from higher in the section, is apparent.

Lamellaptychus lombardicus new form
Pl. 2, Fig. 11

Occurrence: Holotype, 31.5 m (26.5 m), J30765.
Age: Late Berriasian to early Valanginian.

Description: The valve is broadly and flatly arched along the apical-ventral axis and slightly laterally depressed. The semi-angular retroverse turning of the lamellae, getting more rounded towards the adult stage is a characteristic feature of *L. lombardicus*. Nearing the symphyseal margin the lamellae turn ventrally again, meeting the margin in acute angles. On the adult stage the ventral bending gets gradually indistinct.

Lamellaptychi characterized by a retroverse turn of the lamellae, followed by a bending in the opposite direction (ventrally), against the symphyseal margin is repeated higher in the section on *L. bicurvatus* between 71 m (59 m) and 75 m (63 m) of the section (Pl. 3, Fig. 25–28).

Lamellaptychus lombardicus longus new name
Pl. 2, Fig. 10

1938 *Lamellaptychus sub-mortilleti* var. *retroflexa-longa* TRAUTH, Pl. 14, Fig. 7, p. 202, holotype.

Occurrence: 31.5 m (26.5 m), J30766.
Age: Late Berriasian to early Valanginian.
Remarks: The larger holotype comes from the "Grenzschichten des roten und weissen Aptychenkalks von Ober-St. Veit in Wien". Our specimen is preserved as impression from which a positive was prepared. The distinction of this specimen from *L. lombardicus* is its considerable length of the valve (width-length index 0.35, against 0.40 on the larger holotype (TRAUTH 1938, p. 202)). Both display a similar lamellae pattern characterized by a first retroverse bending of the lamellae followed by a ventral turn before touching the symphyseal margin.

Valanginian (Fig. 1)

The interval from 34 m (28 m) to 75 m (63 m) of the Maiolica section, assumed to represent the Valanginian, is conspicuously rich in aptychi. This coincides with observations obtained in cores from Hole 534A and Hole 391C in the Blake-Bahama Basin, as well as from Hole 367 in the Cape Verde Basin (RENZ 1983, Fig. 1, p. 640).

The assemblage of aptychi from Hole 387, Core 49 (Western Bermuda Rise) were considered late Berriasian in age by RENZ (1979a, Fig. 1, p. 591). Based on the results obtained by the present investigations on the Maiolica Formation an early Valanginian age seems more appropriate for this short interval of 4.5 m (Sections 2–4 of Core 49).

Lamellaptychus trauthi new form
Pl. 2, Fig. 12, 13

Occurrence: Holotype, 34 m (28 m), MB201, J30767, Pl. 2, Fig. 12.
Paratype, 34 m (28 m), J30768, Pl. 2, Fig. 13, above base of the Maiolica Formation.
Age: Late Berriasian to early Valanginian.
Description: A round-topped apical-diagonal elevation is dominant on *L. trauthi*. Characteristic are further the narrow lamella curving towards the symphyseal margin and approaching it right-angled, comparable to *L. bermudensis* higher in the section at 42 m

(35 m). From the latter the present form differs by a nearly right-angled bending of the lamellae towards the ventral end of the valve, just before touching the symphyseal margin. The paratype obtained from the same layer displays identical features.

The low position in the section of *L. trauthi* suggests an anchestral relation towards typical *L. bermudensis*.

Lamellaptychus bermudensis RENZ
Pl. 2, Fig. 21–24

1977 *Lamellaptychus* sp., indet. 1, RENZ, Pl. 1, Fig. 23a–b, p. 504 (Cape Verde Basin), holotype.
1978 *Lamellaptychus postbermudensis* RENZ, Pl. 1, Fig. 8a–b, p. 904 (Blake-Bahama Basin).
1979 *Lamellaptychus bermudensis* RENZ, Pl. 1, Fig. 2, p. 592 (Western Bermuda Rise).
1983 *Lamellaptychus postbermudensis* RENZ, Pl. 1, Fig. 11, p. 640 (Blake-Bahama Basin).

Occurrence: 42 m (35m), J30769.
45 m (38 m), MB203, J30770.
45 m (38 m), J30771.
47 m (39 m), J30772.
50 m (42 m), J30773.
50 m (42 m), J30906, Pl. 2, Fig. 22.
50 m (42 m), J30905, Pl. 2, Fig. 23.
50 m (42 m), J30904, Pl. 2, Fig. 24.
72 m (60 m), J30903, Pl. 2, Fig. 21.
75 m (63 m), J30779.

Age: Valanginian.

Remarks: The outstanding features on this easily recognizable form are remarkably constant. The width-length ratio attains: Blake-Bahama Basin 0.44; Western Bermuda Rise 0.46; Cape Verde Basin 0.50; Breggia section 0.49.

Besides of the type with its high apical-diagonal keel over which the lamellae are partly effaced, specimens occur with a lower broader apical-diagonal elevation crossed by the lamellae without being interrupted. This variety (Pl. 2, Fig. 21) occurs together with the type. We do not distinguish it by a new name, as long as comparable informations from other sections become available.

In the Atlantic the rather small-sized valves are noticeable by their widespread occurrence, what indicates that it was a common form within a thick interval of sediment. This coincides with observations in the Maiolica Formation, where *L. bermudensis* was observed between 42 m (35 m) and 75 m (63 m).

L. bermudensis was collected, as early as 1927, by M. Blumenthal in the Betic Cordillera (southern Spain), near Archidona (Provincia Malaga). There it is associated with *L. ambiguus*.

Lamellaptychus planus new form
Pl. 2, Fig. 15a, b

Occurrence: 45.5 m (37.5 m), J30780, above base of the Maiolica Formation.
Age: Early Valanginian.

Description: The single valve representing the holotype is distinguished from *L. mortilleti* by its faintly perceptible apical-diagonal elevation, resulting in a weak inflection of the lamellae and a weak lateral depression of the valve. In common with *L. mortilleti* is a conspicuous turning ventrally of the lamellae along the symphyseal margin. The last adult lamellae, however, do not converge towards the ventral end of the valve, as typical for the *L. mortilleti* group. Instead they contrarily turn sharply retroverse just before touching the symphyseal margin. The first lamellae turning retroverse than meets the end of the former straight one. A comparable pattern is repeated higher in the section in a more conspicuous style (Pl.3, Fig. 21).

Lamellaptychus?, new form
Pl. 2, Fig. 14

Occurrence: Holotype, 46 m (38 m), MB203, J30781, above base of the Maiolica Formation.
Age: Early Valanginian.
Description: The figured left valve only is available. Its apical-diagonal elevation is flattened, and followed by a shallow lateral depression of the valve, connected with an angular inflection of the lamellae. On the juvenile stage the lamellae meet the symphyseal margin straight with angles of about 30°, comparable to *L. herthae* (Pl. 3, Fig. 16–18). The last five adult lamellae bend retroverse after performing a low hook-like turn.

At present this specimen cannot be compared satisfactorily with any known *Aptychus* from the Lower Cretaceous. Its low position within the interval considered to represent the early Valanginian (together with the first *L. bermudensis*) might suggest some affinities to the *L. didayi* group, appearing 9 m higher at 47 m (39 m). It differs from the latter by its closer placed and also weaker, not vertical and sharp edged lamellae. A relation to *L. helveticus* (Pl. 2, 7–9) cannot be excluded. Here the retroverse turning of the lamellae is still more accentuated.

The specimen, still questionable, is left in open nomenclature, as long as additional material becomes disponible.

Lamellaptychus bermudensis levis new variety
Pl. 2, Fig. 19, 20

Occurrence: Paratype, 46 m (38 m), MB203, J30782, Pl. 2, Fig. 20.
Holotype, 50 m (42 m), J30783, Pl. 2, Fig. 19, above base of the Maiolica Formation.
Age: Early Valanginian.
Description: The two specimens, 4 m apart, derive from platy, silicified layers composed entirely of radiolarians. The valve which represents the holotype, is broadly arched and not keeled apical-ventrally as *L. bermudensis*. In this respect it could be compared with *L. aplanatus*. The lamellae are weakly inflected on the lateral slope, and bend rather narrow-angled towards the symphyseal margin, meeting it straight and right-angled, as typical for *L. bermudensis*. The paratype shows identical features. The dark line crossing this valve diagonally on Figure 20 (Pl. 2,) is caused by a fracture.

Lamellaptychus elegans RENZ
Pl. 2, Fig. 16; Pl. 5, Fig. 17, 18

1979 *Lamellaptychus elegans* RENZ, Pl. 1, Fig. 12a–b, p. 593 (Western Bermuda Rise).

Occurrence: 47 m (39 m), J30784, Pl. 2, Fig. 16.
50 m (42 m), J30911, J30910, Pl. 5, Fig. 17, 18, above base of the Maiolica Formation.

Age: Early Valanginian.

Remarks: The presence of *L. elegans* is indicated by several rather deficiently preserved specimens. Their apical-ventral elevation and the resulting inflection of the lamellae are less pronounced if compared with the holotype. Characteristic features are the strengthening and widening of the adult lamellae along their curving towards the ventral end of the valve. *L. elegans* occurs within the range of *L. mortilleti* and some relation towards this form seems indicated.

Lamellaptychus retroflexus TRAUTH
Pl. 2, Fig. 25–32

1938 *Lamellaptychus aplanatus* var. *retroflexa* TRAUTH, Pl. 13, Fig. 24–25, p. 193 (holotype).
1979 *Lamellaptychus aplanatus retroflexus* TRAUTH, RENZ, Pl. 1, Fig. 3a–b, 4, p. 593 (Western Bermuda Rise).
1983 *Lamellaptychus aplanatus retroflexus* TRAUTH, Pl. 1, Fig. 14, p. 640. (Blake-Bahama Basin).

Occurrence: 47 m (39 m), J30785.
50 m (42 m), J30907, Pl. 2, Fig. 25.
53 m (44 m), MB204, J30786.
57 m (47 m), MB205, J30787, Pl. 2, Fig. 32.
62 m (52 m), J30788, Pl. 2, Fig. 26.
62 m (52 m), J30789, Pl. 2, Fig. 27.
62 m (52 m), MB210, J30790.
65 m (54 m), J30791, Pl. 2, Fig. 28.
71 m (59 m), J30792.
71 m (59 m), J30793, Pl. 2, Fig. 29.
75 m (63 m), J30794, Pl. 2, Fig. 31.
86 m (71 m), J30795, Pl. 2, Fig. 30.
87 m (72 m), J30796, above base of the Maiolica Formation.

Remarks: We propose to interprete *L. aplanatus retroflexus* TRAUTH as a separate form, not connected with *L. aplanatus* (GILLIÉRON). The range of *L. retroflexus*, 49 m (39 m) to 87 m (72 m), about coincides with that of *L. aplanatus* from 47 m (39 m) to 87 m (72 m). The intensity of retroverse turning of the lamellae, as well as the hight of the valve seem to be quite unstable features. The retroverse directed lamellae, following the symphyseal margin before touching it, occasionally form a faintly indicated adsymphyseal ridge.

The perfectly preserved valves from 50 m (42 m) and from 62 m (52 m), Plate 2, Figures 25–26, differ from the holotype mainly by their flatness and a slight lateral

depression, connected with distinctly inflected lamellae. Before introducing a new name, additional specimens from other sections are wanted.

Lamellaptychus bahamensis RENZ
Pl. 2, Fig. 17, 18; Pl. 5, Fig. 21–24

1978 *Lamellaptychus bahamensis* RENZ, Pl. 1, Fig. 2, p. 903 (Blake-Bahama Basin).

Occurrence: 47 m (39 m), J30797, Pl. 2, Fig. 17.
50 m (42 m), J30913, J30914, J30915, J30916, Pl. 5, Fig. 21–24.
70 m (58 m), J30798, Pl. 2, Fig. 18.
75 m (63 m), J30799, above base of the Maiolica Formation.
Age: Late Valanginian.
Remarks: Main features are a pronounced apical-diagonal elevation followed laterally by a flat depression, connected with a marked angular inflection of the lamellae which follow the symphyseal margin, touching it acute-angled. The adult lamellae follow along the ventral facet and do not converge towards the ventral end of the valve, as on *L. mortilleti* (RENZ 1978, Fig. 2, p. 902).

The form might be interpreted as a precursor of *L. morbiensis* (Pl. 4, Fig. 4, 10) higher in the section at 75 m (63 m). Here the adult lamellae follow parallel to the symphyseal margin, and end along the ventral facet, comparable to *L. beyrichi*. The variability of this form is displayed by four samples (J30913–J30916), all from an intercalation of coaly shale 0.5 cm thick.

Lamellaptychus challengeri RENZ
Pl. 2, Fig. 33; Pl. 3, Fig. 1, 2

1977 *Lamellaptychus* sp. indet. 2, RENZ, Pl. 1, Fig. 24a–c, p. 504 (Cape Verde Basin).
1978 *Lamellaptychus challengeri* RENZ, Pl. 1, Fig. 4a–b, p. 903 (Blake-Bahama Basin).

Occurrence: 47 m (39 m), J30800.
50 m (42 m), J30801, Pl. 2, Fig. 33.
51 m (43 m), J30803, Pl. 3, Fig. 2.
62 m (51 m), MB210, J30802, Pl. 3, Fig. 1.
72 m (60 m), J30897.
75 m (63 m), J30804, above base of the Maiolica Formation.
Age: Valanginian.
Remarks: In the Breggia section this readily recognizable form is less abundant, and has a more restricted range than *L. bermudensis*. It is easily to be distinguished from *L. bermudensis* by its greater width of the valve (width-length ratio 0.61, against 0.50 for *L. bermudensis*). *L. challengeri* is accompanied by *L. symphysocostatus*.

Lamellaptychus aplanatus (GILLIÉRON)
Pl. 3, Fig. 4–11

1873 *Aptychus aplanatus* (GILLIÉRON, Pl. 10, Fig. 4, p. 238.
1938 *Lamellaptychus aplanatus* (GILLIÉRON), TRAUTH, Pl. 12, Fig. 8–10, p. 171.
1977 *Lamellaptychus aplanatus* (GILLIÉRON), RENZ, Pl. 1, Fig. 25a–b, p. 504 (Cap Verde Basin).

1978 *Lamellaptychus aplanatus* (GILLIÉRON), RENZ, Pl. 1, Fig. 7, p. 904 (Blake-Bahama Basin).

Occurrence: 47 m (39 m), J30805.
47 m (39 m), J30816, Pl. 3, Fig. 9.
50 m (42 m), J30806.
51 m (43 m), J30807.
54 m (45 m), J30808, Pl. 3, Fig. 4.
61.5 m (51 m), J30810, Pl. 3, Fig. 11.
62 m (51 m), MB209, J30809.
70 m (58 m), J30811.
71 m (59 m), J30812, Pl. 3, Fig. 5.
75 m (63 m), J30813, Pl. 3, Fig. 6.
75 m (63 m), J30814, Pl. 3, Fig. 7.
78 m (64 m), MB208, J30815, Pl. 3, Fig. 8.
87 m (72 m), MB61, J30817.
87 m (72 m), J30818, Pl. 3, Fig. 10, above base of the Maiolica Formation.

Age: Valanginian.

Remarks: Within the Maiolica Formation *L. aplanatus* is distinguished by its long range, abundance and considerable variations.

The predominantly medium-sized valves are broadly arched without a marked apical-diagonal keel and a lateral depression of the valve. Specimens with a slight lateral depression might be interpreted as transitions towards *L. herthae* (Pl. 3, Fig. 16–18). The lamellae on typical specimens lie flat and are broad (Pl. 3, Fig. 6–9). What concerns the height of the valve and the width (spacing) of the lamellae, *L. aplanatus* is quite variable.

The specimens 54 m (45 m), Pl. 3, Fig. 4, and 75 m (63 m), Pl. 3, Fig. 7, represent such variations. The slender valves are remarkable by their densely-spaced and narrow lamellae. A relation of the varieties to their stratigraphic position cannot be recognized with the material in hand. The introduction of additional names seems therefore premature.

Lamellaptychus subdidayi TRAUTH
Pl. 3, Fig. 3

1867 *Aptychus Didayi* PICTET, Pl. 28, Fig. 6a–b, p. 122.
1938 *Lamellaptychus subdidayi* TRAUTH, Pl. 12, Fig. 25, refigured holotype: Pl. 12, Fig. 26–28.

Occurrence: 47 m (39 m), J30898.
59 m (49 m), MB206, J30833, Pl. 3, Fig. 3.
75 m (63 m), J30834, above base of the Maiolica Formation.

Age: Valanginian.

Remarks: The lamellae on the juvenile stage meet the symphyseal margin in acute angles. Progressively the angles widen and the lamellae simultaneously get broader, steeper and sharp edged. On the adult stage the widely curved lamellae meet the symphyseal margin near to right-angled, ending in a distinct adsymphyseal ridge.

In the Breggia section *L. subdidayi,* so far, seems to be restricted within the range of *L. bermudensis* and *L. retroflexus*.

Lamellaptychus didayi (COQUAND)
Pl. 4, Fig. 5, 6

1841 *Aptychus didayi* COQUAND, Pl. 1, Fig. 10, p. 389.
1858 *Aptychus didayi* COQUAND, PICTET & LORIOL, Pl. 10, Fig. 2, p. 46.
1867 *Aptychus didayi* COQUAND, PICTET, Pl. 28, Fig. 6, 7, p. 122.
1868 *Aptychus didayi* COQUAND, WINKLER, Pl. 4, Fig. 16, p. 28.
1938 *Lamellaptychus didayi* (COQUAND), TRAUTH, Pl. 14, Fig. 3 only, p. 198, reproduction of holotype.
1977 *Lamellaptychus didayi* (COQUAND), RENZ, Pl. 1, Fig. 26a–c, p. 505 (Cape Verde Basin).

Occurrence: 50 m (42 m), J30819, Pl. 4, Fig. 5.
71 m (59 m), J30820, Pl. 4, Fig. 6, above base of the Maiolica Formation.
Age: Valanginian.
Remarks: The juvenile stage of *L. didayi* is characterized by narrow and thin lamellae meeting the symphyseal margin in acute angles. Soon a retroverse bending of the lamellae begins what is connected with a broadening and steepening and getting sharp-edged along the curving. A distinct adsymphyseal ridge which seems connected with the retroverse turning of the lamellae (continuation along the symphysis) is developed along the symphyseal margin.

Lamellaptychus herthae (WINKLER)
Pl. 3, Fig. 16–18

1868 *Aptychus Herthae* WINKLER, Pl. 4, Fig. 12, p. 28.
1938 *Lamellaptychus herthae* (WINKLER), TRAUTH, Pl. 12, Fig. 22, p. 178.
1977 *Lamellaptychus* aff. *herthae* (WINKLER), RENZ, Pl. 1, Fig. 31, 32, p. 505 (Cape Verde Basin).
1978 *Lamellaptychus* cf. *herthae* (WINKLER), RENZ, Pl. 1, Fig. 11a–b, p. 904 (Blake-Bahama Basin).
1983 *Lamellaptychus herthae* (WINKLER), RENZ, Pl. 1, Fig. 17, p. 640 (Blake-Bahama Basin).

Occurrence: 50 m (42 m), J30821.
54 m (45 m), J30822, Pl. 3, Fig. 16.
62 m (51 m), MB209, J30823, Pl. 3, Fig. 17.
68 m (56 m), J30824, Pl. 3, Fig. 18.
75 m (63 m), J30825, above base of the Maiolica Formation.
Age: Late Valanginian.
Remarks: L. herthae is distinguished by a broad apical-diagonal elevation with an adjoining lateral depression of the valve. This differs *L. herthae* from *L. aplanatus,* without a lateral depression. The lamellae are distinctly inflected and meet the symphyseal margin straight within angles of 30° to 40°.

In the Breggia section *L. herthae* is accompanied by *L. bermudensis,* as well as *L. challengeri.*

The comparison of juvenile, rather deficiently preserved specimens from the Atlantic with *L. herthae* (RENZ 1977, p. 505, and 1978, p. 904) remains questionable.

Lamellaptychus symphysocostatus TRAUTH
Pl. 3, Fig. 12–14

1938 *Lamellaptychus angulocostatus* var. *symphysocostata* TRAUTH, Pl. 14, Fig. 15, 16, p. 208.

Occurrence: 50 m (42 m), J30826.
51 m (43 m), J30827, Pl. 3, Fig. 12.
62 m (51 m), J30828.
78 m (64 m), MB208, J30829, Pl. 3, Fig. 13, above base of the Maiolica Formation.

Age: Valanginian.

Remarks: The pattern of the lamellae resembles closely to that on *L. angulocostatus* from the Barremian, as indicated by the name given by TRAUTH (1938, p. 208). Decisive for a separation of the present specimens from *L. angulocostatus* are not primarily morphological aspects, but mainly the considerable interval of time parting the two forms. This evidently should be reflected also in the taxonomy.

L. symphysocostatus is characterized by a first sharp-angled, later rounded retroverse turning of the lamellae, close to the symphyseal margin. A further characteristic feature is the continuation of the lamellae, diagonally over the symphyseal facet, meeting the edge of the symphysis on the concave side of the valve, with angles of about 60° (Pl. 3, Fig. 13).

For comparison we reproduce a well preserved specimen (Pl. 3, Fig. 14, J30877), collected by M. Blumenthal, during 1927, in the Betic Cordillera (southern Spain), near Archidona (Provincia Malaga). Its stratigraphic position remains unknown.

Lamellaptychus ambiguus RENZ
Pl. 3, Fig. 21, 22

1979 *Lamellaptychus ambiguus* RENZ, Pl. 1, Fig. 13a–b, p. 593 (Western Bermuda Rise).

Occurrence: about 50 m (42 m), J30830, Pl. 3, Fig. 22.
58 m (47 m), J30831, Pl. 3, Fig. 21, above base of the Maiolica Formation.

Holotype: The reconstruction of the holotype as drafted by RENZ (1979, Pl. 1, Fig. 13b) is not correct, as shown by completer preserved material available at present.

Age: Valanginian.

Remarks: On the juvenile stage the lamellae lean towards the symphyseal margin before ending against it. Later, approaching the adult stage, the lamellae broaden and bend ventrally just before meeting the margin. Suddenly a retroverse turn of the lamellae sets in, such that the end of the first retroverse lamella meets the end of the former straight one. The retroverse ends of the lamellae merge into an outstanding adsymphyseal ridge.

Lamellaptychus aff. *ambiguus* RENZ
Pl. 5, Fig. 19, 20

Occurrence: 50 m (42 m), J30918, J30919, Pl. 5, Fig. 19, 20, above base of the Maiolica Formation.

Age: Valanganian.

Remarks: From typical *L. ambiguus* the present two specimens differ by a distinct interference between the lamellae which follow parallel to the symphyseal margin on the juvenile stage with the lamellae turning towards the margin, meeting it right-angled towards the adult stage.

A separation of the present specimen from *L. ambiguus* (Pl. 3, Fig. 21) might be indicated. This only can be confirmed by additional material.

Lamellaptychus aff. *noricus* (WINKLER)
Pl. 3, Fig. 19

1868 *Aptychus noricus* WINKLER, Pl. 4, Fig. 14, p. 27.
1938 *Lamellaptychus noricus* WINKLER, Pl. 13, Fig. 5, p. 89.
1979a *Lamellaptychus mortilleti noricus* Trauth, Renz, Pl. 1, Fig. 6–7, p. 593 (Western Bermuda Rise).

Occurrence: 57 m (47 m), MB205, J30832, above base of the Maiolica Formation.
Age: Valanganian.
Remarks: The single specimen, with its ventral end missing, can best be compared with the larger sized holotype, as well as with a juvenile pair of valves from the Western Bermuda Rise. The subrectangular outline of the valve seems to be a typical feature. The densely-spaced narrow lamellae follow the lateral and ventral facets and meet the symphyseal margin near to right-angled towards the adult stage.

Laevilamellaptychus ? new form
Pl. 5, Fig. 25

1897 *Aptychus* sp., STEUER, Pl. 24, Fig. 3, p. 19, 78 (Argentina).
1936a *Laevilamellaptychus* f., TRAUTH, Pl. 3, Fig. 8, 9, p. 136 (reproduction of specimens from Argentina).

Occurrence: 57 m (47 m), MB205, J30912, Pl. 5, Fig. 25.
Age: Valanginian.
Remarks: The name *Laevilamellaptychus* TRAUTH is based on specimens from the Dogger in Germany (TRAUTH 1930, p. 363.). Earlier such specimens formed part of *Cornaptychus* (TRAUTH 1927, p. 237).

The Valanginian age of our specimen of *Laevilamellaptychus* is confirmed by the presence of *L. bermudensis, L. retroflexus* and *L. ambiguus* within 57 m (47 m). Most outstanding features on our specimen, are the very slender elongated outline of the valve, its acute ventral end leaving no space for a lateral facet and its high keel falling-off steep towards the symphyseal margin. Also the sculpture consisting of very narrow and thin lamellae which meet the symphyseal margin with angles of about 30° are comparable with the specimens from the Andes in Argentina (Arroyo Cieneguita, Sierra de Malargue). The age of the specimen from Argentina is indicated as early Tithonian.

Our knowledge on this form is still very restricted. This prevents us to introduce a new name for the specimen from the Maiolica Formation.

Lamellaptychus carinatus new form
Pl. 3, Fig. 20a, b

Occurrence: 59 m (49 m), MB206, J30835, above base of the Maiolica Formation.
Age: Valanginian.
Remarks: The present specimen is distinguished by its very pronounced apical-diagonal keel, declining nearly vertical laterally. The adult lamellae on the lateral slope of the keel are partly angularly inflected. Along the less steep slope towards the symphyseal margin the lamellae first bend sinuously ventrally before curving towards the symphyseal margin, meeting it in acute angles. This second bending implies a widening of the lamellae, similar to *L. elegans* (Pl. 2, Fig. 16). The last lamellae converge towards the ventral end of the valve, comparable to *L. mortilleti.*

Lamellaptychus aff. *symphysocostatus* TRAUTH
Pl. 3, Fig. 15a–b

Occurrence: 62 m (51 m), MB209, J30836, above base of the Maiolica Formation.
Age: Valanginian.
Remarks: This single valve was found within the range of typical *L. symphysocostatus.* The feature common with the latter are the retroverse turning of the lamellae close to the symphyseal margin. The present specimen differs from the holotype of *L. symphysocostatus* TRAUTH (1938) by its very narrowly placed lamellae some of which are branching towards the adult stage.

A new name for the present form might be justified when additional material clarifies the relation to typical *L. symphysocostatus.*

Lamellaptychus aff. *angulodidayi* TRAUTH
Pl. 3, Fig. 23

Occurrence: 70 m (58 m), J30837, above base of the Maiolica Formation.
Age: Late Valanganian.
Remarks: On the present specimen not all features coincide satisfactorily with those on the holotype of *L. angulodidayi* from Castellane (Département Basses Alpes) in southern France. A specimen from higher in the section at 75 m (63 m) shows *L. angulodidayi* more convincingly represented (Pl. 4, Fig. 7).

On the juvenile stage the rather narrow lamellae approach the symphyseal margin following and touching it very acute-angled. The broader adult lamellae turn retroverse quite close to the symphyseal margin without forming an adsymphyseal ridge. This mainly distinguishes the present specimen from typical *L. angulodidayi* (Pl. 4, Fig. 7). On *L. ambiguus* (Pl. 3, Fig. 21, 22) from deeper in the section, 50 m (42 m) to 58 m (47 m), the retroverse turn of the last adult lamellae is still less pronounced.

Additional specimens of this group of lamellaptychi might help to clarify the taxonomic value concerning the apparent unstable approach of the lamellae towards the symphyseal margin with progressing age.

Lamellaptychus bicurvatus new name
Pl. 3, Fig. 25–28

1938 *Lamellaptychus sub-mortilleti* var. *retroflexa* TRAUTH, Pl. 14, Fig. 6, p. 201, holotype.
1961 *Lamellaptychus submortilleti* var. *retroflexa* TRAUTH, STEPHANOV, Pl. 3, Fig. 7, p. 220 (Bulgaria).

Occurrence: 71 m (59 m), J30838, Pl. 3, Fig. 25.
71 m (59 m), J30839, Pl. 3, Fig. 27.
71 m (59 m), J30840, Pl. 3, Fig. 28.
75 m (63 m), J30841, Pl. 3, Fig. 26, above base of the Maiolica Formation.
Age: Late Valanginian.
Remarks: The valve is broadly arched along the apical-diagonal line. On its juvenile stage the lamellae approaching the symphyseal margin bend ventrally, closely following the margin before touching it. Towards the adult stage the lamellae strengthen and their width increases consecutively. They turn retroverse in a broad bow, and before touching the symphyseal margin, reverse ventrally again before meeting the margin, The lamellae on our specimens are weakly inflected, what is not visible on the holotype from Gresten in the Austrian Alps, because its dorsal half is missing.

L. bicurvatus seems not related to *L. lombardicus* (early Valanginian) displaying a comparable lamellae pattern (Pl. 2, Fig. 10, 11).

The flatness of the valve induced TRAUTH (1938) to unite this form with *L. submortilleti:* "... durch das Fehlen einer Flankendepression und einer deutlichen apicaldiagonalen Kielwölbung ..." (p. 201).

Lamellaptychus ? aff. *L. bicurvatus* new form?
Pl. 3, Fig. 24

Occurrence: 71 m (59 m), J30842, above base of the Maiolica Formation.
Age: Late Valanginian.
Description: The fragment representing an adult stage can possibly be attached to *L. bicurvatus* (Pl. 3, Fig. 25–28). The juvenile lamellae (upper right end on Fig. 24) touch the symphyseal margin in acute angles. Later the lamellae perform acute-angled bends before approaching the symphyseal margin right-angled, and just before touching the margin they turn ventrally again, comparable to *L. bicurvatus* (Pl. 3, Fig. 25–28) from the same strata. The last preserved lamellae then turn slightly retroverse towards the margin touching it straight. An adsymphyseal ridge is not developed.

This still questionable fragment cannot be interpreted without fully preserved additional specimens.

Lamellaptychus ticinensis new name
Pl. 3, Fig. 29–31; Pl. 4, Fig. 1–3

1867 *Aptychus Seranonis* COQUAND, PICTET (partim), Pl. 28, Fig. 10b, c, p. 123, holotype.
1938 *Lamellaptychus mortilleti* (PICTET & LORIOL), TRAUTH, Pl. 10, Fig. 27–28, p. 145 (refigured holotype).

Occurrence: 75 m (63 m), J30843, Pl. 3, Fig. 29.
75 m (63 m), J30844, Pl. 3, Fig. 30.
75 m (63 m), J30845, Pl. 3, Fig. 31.
75 m (63 m), J30846, Pl. 4, Fig. 1.
75 m (63 m), J30847, Pl. 4, Fig. 2.
79 m (65 m), J30848, Pl. 4, Fig. 3, above base of the Maiolica Formation.
Age: Late Valanginian.
Description: 12 specimens from an interval about 2 m thick are available. All display stable features coinciding satisfactorily with the holotype from Berrias (Ardèche). The present specimens are broadly arched and highest along the apical-diagonal line, which is followed by a flat lateral depression of the valve, connected with a feeble inflection of the lamellae. Shortly before touching the symphyseal margin the lamellae turn ventrally in wide angles.

Variations within the material disponible are restricted to the adult lamellae which broaden and than meet the symphyseal margin right-angled or even faintly retroverse (Pl. 3, Fig. 31; Pl. 4, Fig. 2).

Lamellaptychus morbiensis new form
Pl. 4, Fig. 4, 10

Occurrence: 75 m (63 m), J30849, Pl. 4, Fig. 4, holotype.
75 m (63 m), J30850, Pl. 4, Fig. 10, paratype, above base of the Maiolica Formation.
Age: Late Valanginian.
Description: The narrowly and highly-arched valve along the apical-diagonal line is laterally slightly depressed. The narrow, closely placed lamellae are distinctly angularly inflected. Approaching the symphyseal margin they slightly curve towards the ventral end of the valve, meeting the margin in acute angles. The lamellae converge towards the ventral termination of the valve, the last ones ending along the ventral facet.

L. mortilleti from considerably deeper in the section shows a similar lamellae pattern. No indications for a relation between the two forms are, however, indicated so far. Additional material might allow new perceptions.

Lamellaptychus angulodidayi TRAUTH
Pl. 4, Fig. 7

1846 *Aptychus Didayi* QUENSTEDT, Pl. 22, Fig. 21, p. 314.
1938 *Lamellaptychus angulo-didayi* TRAUTH, Pl. 14, Fig. 28–29 only, p. 212, refigured holotype.

Occurrence: 75 m (63 m), J30851, above base of the Maiolica Formation.
Age: Late Valanginian.
Remarks: Our specimen differs from the holotype by its less pronounced, wider angulated and weak retroverse turn of the lamellae on the adult stage. An adsymphyseal ridge is not developed. A crossing of the lamellae over the symphyseal facet, observed on the holotype, is not visible.

Lamellaptychus form indet.
Pl. 4, Fig. 8

Occurrence: 75 m (63 m), J30852, above base of the Maiolica Formation.
Age: Late Valanginian.
Remarks: The juvenile lamellae on this still questionable fragment perform a hook-like bending before turning slightly retroverse. The last three adult lamellae approach the symphyseal margin first straight, later slightly retroverse (last two lamellae). A prominent adsymphyseal ridge is developed.

Lamellaptychus mendrisiensis new form
Pl. 4, Fig. 9

Occurrence: 75 m (63 m), J30853, above base of the Maiolica Formation.
Age: Late Valanginian.
Description: The single valve available is broadly and highly arched along the apical-diagonal axis. The steeply declining lateral slope of the valve is not depressed, nevertheless the lamellae are distinctly inflected. On the juvenile stage the lamellae approaching the symphyseal margin bend ventrally, and meet the margin in very acute angles. On the adult stage the last six straight lamellae progress parallel to the margin ending narrowly placed along the ventral facet, nearby the ventral termination of the valve.

A connection of *L. mendrisiensis* with *L. beyrichi* from the late Tithonian seems improbable. A relation of *L. bahamensis* from lower in the section, at 70 m (58 m), to the present form might be considered. Additional material is wanted for a clarification.

Hauterivian (Fig. 1)

The interval delimited between 75 m (63 m) and 110 m (92 m) of the Maiolica Formation is attributed to the Hauterivian. It is distinguished by its scarcity of specimens, as well as forms of aptychi. This observation is not restricted to the Breggia section. In DSDP holes in the northern Atlantic comparable conditions are indicated. Concerning its background nothing conclusive is known at present.

All aptychi, so far obtained from the interval, are distinguished by a distinct retroverse turn of the lamellae.

Lamellaptychus subseranonis RENZ
Pl. 4, Fig. 11–16, 18, 21

1978 *Lamellaptychus subseranonis* RENZ, Pl. 1, Fig. 12, p. 904 (Blake-Bahama Basin).
1983 *Lamellaptychus subseranonis* RENZ, Pl. 1, Fig. 9, p. 640 (Blake-Bahama Basin).

Occurrence: 75 m (63 m), J30854, Pl. 4, Fig. 11.
75 m (63 m), J30855, Pl. 4, Fig. 12.
79 m (66 m), J30856.
86 m (71 m), J30899.
86 m (71 m), J30857, MB61, Pl. 4, Fig. 13.
86 m (71 m), J30858, Pl. 4, Fig. 14.
86 m (71 m), J30859, Pl. 4, Fig. 15.

86 m (71 m), J30860, Pl. 4, Fig. 16.
86 m (71 m), J30866, Pl. 4, Fig. 21.
89 m (74 m), J30861, Pl. 4, Fig. 18.
97 m (81 m), J30900.

Age: Late Valanginian to Hauterivian.

Remarks: According to present observations *L. subseranonis* is found within an interval of 18 m of the Maiolica section. The form is distinguished by its considerable variability mainly in what the hight of the valves and their outlines are concerned. The valves from 75 m (63 m) on Plate 1, Figures 11 and 12, are slightly laterally depressed causing a weak inflection of the lamellae. On specimens from higher in the section the depression disappears and the lamellae straighten. Generally a distinct adsymphyseal ridge is developed.

The name indicates that *L. subseranonis* might be interpreted as an antecedent of typical *L. seranonis* from somewhat higher in the section. This assumption, however, is not sufficiently verified with the material in hand. Correlations with other sections are necessary.

Lamellaptychus seranonis (COQUAND)
Pl. 4, Fig. 17, 19, 23; Pl. 5, Fig. 2–6

1841 *Aptychus Seranonis* COQUAND, Pl. 9, Fig. 13, p. 390.
1858 *Aptychus Seranonis* COQUAND, PICTET & LORIOL, Pl. 11, Fig. 1–8, p. 48.
1867 Non *Aptychus seranonis* COQUAND, PICTET, Pl. 28, Fig. 9b, p. 123.
1938 *Lamellaptychus seranonis* (COQUAND), TRAUTH, Pl. 13, Fig. 27, 28 only, p. 193.
1972 *Lamellaptychus seranonis* (COQUAND), RENZ, Pl. 3, Fig. 4, 5, p. 615 (Hatteras Abyssal Plain).
1977 *Lamellaptychus seranonis* (COQUAND), RENZ, Pl. 1, Fig. 27–29, p. 506 (Cape Verde Basin).
1978 *Lamellaptychus seranonis* (COQUAND), RENZ, Pl. 1, Fig. 13, 15, p. 905 (Blake-Bahama Basin).
1983 *Lamellaptychus seranonis* (COQUAND), RENZ, Pl. 1, Fig. 6, p. 640 (Blake-Bahama Basin).

Occurrence: 87 m (72 m), J30863, Pl. 4, Fig. 17.
97 m (81 m), J30864, Pl. 4, Fig. 19.
103 m (85 m), J30865.
105 m (87 m), J30983.
110 m (92 m), J30867, Pl. 4, Fig. 23.
110 m (92 m), J30889–30893, Pl. 5, Fig. 2–6.

Age: Hauterivian.

Remarks: L. seranonis, so far, seems to be restricted to a relatively narrow interval between 87 m (72 m) and 110 m (92 m). An adsymphyseal ridge, as common on *L. subseranonis* deeper in the section is not developed. The specimens figured show considerable variations, especially what the intensity of inflection of the lamellae is concerned.

Lamellaptychus seranonis fractocostus TRAUTH
Pl. 4, Fig. 20, 24, 25; Pl. 5, Fig. 1

1938 *Lamellaptychus seranonis* var. *fractocosta* TRAUTH, p. 197 (not figured).
1978 *Lamellaptychus seranonis fractocostus* TRAUTH, RENZ 1978, Pl. 1, Fig. 14, p. 905 (Blake-Bahama Basin), holotype here designated.

Occurrence: 97 m (81 m), J30869, Pl. 4, Fig. 20.
107 m (89 m), J30870, Pl. 4, Fig. 25.
110 m (92 m), J30871, Pl. 4, Fig. 24.
110 m (92 m), J30882, Pl. 5, Fig. 1.
Age: Hauterivian.
Remarks: The intensity of inflection ("fracturing") of the lamellae is a variable feature. Conform with typical *L. seranonis* an adsymphyseal ridge is not developed on such variations from the Breggia section.

Lamellaptychus tethis new form
Pl. 4, Fig. 22

1979b *Lamellaptychus* sp., RENZ, Pl. 2, Fig. 8 (west of the Iberian Peninsula, south of Vigo Seamount (DSDP Site 398D)).

Occurrence: 97 m (81 m), J30862, above base of the Maiolica Formation.
Age: About mid Hauterivian.
Description: The ventral half of a left valve compares conspicuously well with a similar fragment (J28220) from the Aptian in Site 398D (40°70.6 N; 10°43.1 W). The steep and high, sharp-edged, very wide-spaced lamellae curve retroverse in a wider bow and merge with a pronounced adsymphyseal ridge, what implies deep hollows between the lamellae adjoining the ridge. Evidently additional material is necessary to appreciate this form.

Barremian (Fig. 1)

The presence of the ammonite genus *Pulchellia* beneath the top of the Blake-Bahama Formation (Leg 76, Site 534A, DSDP, Core 51, Section 1, 101–104 cm) implies a revision of age assignments for sediments containing *L. angulocostatus*. In previous DSDP contributions on aptychi the respective deposits were considered to be Hauterivian in age. According to present knowledge, based on *Pulchellia,* a Barremian age seems more appropriate for intervals containing *L. angulocostatus* in the Blake-Bahama Formation, as well as in the Maiolica Formation.

In the upper 30 m of the Maiolica Formation the group of *L. angulocostatus* dominates and it is typically developed.

Lamellaptychus angulocostatus (PETERS)
Pl. 5, Fig. 9, 10, 12, 15

1858 *Aptychus angulocostatus* PETERS, PICTET & LORIOL, Pl. 10, Fig. 3–12, p. 46.
1938 *Lamellaptychus angulocostatus* (PETERS), TRAUTH, Pl. 14, Fig. 12–13, p. 204.
1942 *Lamellaptychus angulocostatus* (PETERS), IMLAY, Pl. 11, Fig. 8–10, p. 1459.

1961 *Lamellaptychus angulocostatus* (PETERS), STEPHANOV, Pl. 1, Fig. 1–4, 6, p. 212 (Bulgaria).
1965 *Lamellaptychus angulocostatus* (PETERS), FAZZINI, Pl. 1, Fig. 1–8, Pl. 1 (cum synon.).
1972 *Lamellaptychus angulocostatus* (PETERS), RENZ, Pl. 4, Fig. 1–5, p. 616 (Hatteras Abyssal Plain).
1973 *Lamellaptychus* sp., RENZ, Pl. 1, Fig. 5, p. 896 (Magellan Rise, Central Pacific).
1974 *Lamellaptychus angulocostatus* (PETERS), HOUSA, Pl. 1–10, p. 1–57 (cum synon.).
1977 *Lamellaptychus angulocostatus* (PETERS), RENZ, Pl. 1, Fig. 35; Pl. 2, Fig. 1–2, p. 506 (Cape Verde Basin).
1978 *Lamellaptychus angulocostatus planus* (RENZ), Pl. 1, Fig. 16, p. 905 (Blake-Bahama Basin).
1979b *Lamellaptychus angulocostatus* (PETERS), RENZ, Pl. 2, Fig. 9, p. 361 (south of Vigo Seamount, west of Iberian Peninsula).
1983 *Lamellaptychus angulocostatus* (PETERS), RENZ, Pl. 1, Fig. 2, 5, p. 640 (Blake-Bahama Basin).

Occurrence: 109.5 m, DB 2718b, J30872, Pl. 5, Fig. 9.
118.5 m, DB 2720, J30884, Pl. 5, Fig. 12.
123 m (102 m), J30900.
133 m (110 m), MB87c, J30885, Pl. 5, Fig. 10.
136 m (113 m), J30830.
144 m (118.5 m), DB 2721, J30894, Pl. 5, Fig. 15, above base of the Maiolica Formation.

Age: Barremian.

Remarks: A transition of *L. seranonis* towards *L. angulocostatus* is indicated on specimen Figure 6 (Pl. 5). This specimen from 110 m (92 m), shows the juvenile stage of *L. seranonis* where the lamellae approach the symphyseal margin in a retroverse bow. In the middle of the valve the bow turns faintly angular and later on the adult stage rounded again. On *L. angulocostatus cristobalensis* on Plate 5, Figure 7, 109.5 m, the angular turn of the lamellae persists from the juvenile until the adult stage where a gradual rounding occurs.

Lamellaptychus angulocostatus cristobalensis (O'CONNELL)
Pl. 5, Fig. 7, 11, 13

1921 *Aptychus cristobalensis* O'CONNELL, Fig. 7, p. 7.
1938 *Lamellaptychus angulocostatus* var. *cristobalensis* (O'CONNELL), TRAUTH, Pl. 14, Fig. 26, p. 211.
1961 *Lamellaptychus angulocostatus cristobalensis* (O'CONNELL), STEPHANOV, Pl. 1, Fig. 11, p. 213 (Bulgaria).
1977 *Lamellaptychus angulocostatus* aff. *cristobalensis* (O'CONNELL), RENZ 1977, Pl. 2, Fig. 3, p. 507 (Cape Verde Basin).

Occurrence: 109.5 m, DB 2718a, J30886, Pl. 5, Fig. 7.
133 m (110 m), MB87, J30876, Pl. 5, Fig. 11.
133 m (110 m), MB87b, J30887, Pl. 5, Fig. 13, above base of the Maiolica Formation.

Age: Barremian.

Remarks: Three specimens are distinguished by round curving instead of angulate lamellae on the adult stage. The variety occurs contemporaneously with typical *L. angulocostatus*.

Lamellaptychus aff. *angulocostatus* (PETERS)
Pl. 5, Fig. 8

cf. 1961 *Lamellaptychus angulocostatus* var. *atlantica* (HENNIG), STEPHANOV, Pl. 1, Fig. 12, p. 215 (Bulgaria).

Occurrence: 126 m (105 m), MB81, J30883, above base of the Maiolica Formation.
Age: Barremian.
Remarks: From typical *L. angulocostatus* this specimen differs by its angular turning of the lamellae remarkably close to the symphyseal margin. In this respect it approximates *L. symphysocostatus* TRAUTH (1938, Pl. 14, Fig. 15, 16, p. 208) which, however, occurs lower in the section between 50 m (42 m) and 78 m (64 m).

Lamellaptychus atlanticus (HENNIG)
Pl. 5, Fig. 14, 16

1913 *Aptychus atlanticus* (HENNIG, Pl. 2, Fig. 1a–b, p. 155.
1938 *Lamellaptychus angulocostatus* var. *atlantica* (HENNIG), TRAUTH, Pl. 14, Fig. 19, p. 210, refigured holotype.
1972 *Lamellaptychus angulocostatus atlanticus* (HENNIG), RENZ 1972, Pl. 4, Fig. 2a, 3, p. 617 (Hatteras Abyssal Plain).
1974 *Lamellaptychus atlanticus* HENNIG, HOUSA, Pl. 8, Fig. 2, p. 72.
1983 *Lamellaptychus angulocostatus atlanticus* (HENNIG), RENZ, Pl. 1, Fig. 3, p. 640 (Blake-Bahama Basin).

Occurrence: 133 m (110 m), MB87b, J30917, Pl. 5, Fig. 16.
144 m (119 m), DB 2720, J30900, Pl. 5, Fig. 14, above base of the Maiolica Formation.
Remarks: This small, widely known form shows angulate retroverse turning lamellae restricted on the juvenile stage. Soon the narrowly placed lamellae turn rounded and remain so until the adult stage.

E. Correlation of the Maiolica Formation in the Breggia river with the Blake-Bahama Formation in the North Atlantic (Fig. 3).

Accurately defined boundaries delimiting stages between Tithonian and Barremian, based on aptychi and on a few compressed ammonites have so far, not been established in holes drilled in the North Atlantic. Intervals with remains of Cephalopoda are scattered, particularly in the Atlantic (Holes 434A and 391C, Blake-Bahama Basin).

For the correlation proposed here two groups of observations are of fundamental importance.

a) Apparently synchronous changes in lithology observed in the western North Atlantic as well as in the Breggia section, suggesting correlations of the Rosso ad Aptici with the Cat Gap Formation and of the Maiolica with the Blake-Bahama Formation.