27. EARLY CRETACEOUS CEPHALOPODA FROM THE BLAKE-BAHAMA BASIN (DEEP SEA DRILLING PROJECT LEG 76, HOLE 534A) AND THEIR CORRELATION IN THE ATLANTIC AND SOUTHWESTERN TETHYS[1]

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INTRODUCTION

Deep Sea Drilling Project Hole 534A of Leg 76 was drilled in the Blake-Bahama Basin about 500 km east of Florida (28°20.6′N, 75°22.9′W). It is situated east of the Blake Plateau escarpment and north of Hole 391C (28°13.61′N, 75°37.00′W), which also furnished remains of cephalopods. The purpose of drilling at Hole 534A was to reach the oceanic basement and to investigate the oldest sediment overlying it, thought to have been deposited in the Middle Jurassic.

The main objective of the present study is to increase our knowledge about the correlation of ammonites and aptychi in the Lower Cretaceous of Hole 534A. This knowledge can improve our delineation of stage boundaries.

Between 980 and 1380 m sub-bottom (i.e., between Cores 51 and 96), 21 core samples with macrofossils were recovered. The range in age of the fossils examined reaches from latest Tithonian (Core 96) to late Barremian (Core 51). The interval between Cores 51 and 92 is within the Blake-Bahama Formation. Its lithology consists predominantly of pelagic laminated marls, calcareous siltstones, and claystones showing light gray to whitish shades. The sediment below Core 92 is composed of calcareous claystones characterized by reddish brown colors. The interval between Cores 92 and 96 represents the upper part of the Cat Gap Formation. The contact between the Blake-Bahama Formation and the Cat Gap Formation is placed at Core 92. (See Site 534 report, this volume).

Determinable macrofossils are present in 19 of the 21 samples available. All belong to the Class Cephalopoda Cuvier, 1797. The order Ammonoidea is represented by four ammonites and 15 Lamellaptychi. Three ammonites belong to the Ammonitina Hyatt, 1889, and only one belongs to the Lytoceratina Hyatt, 1889. Decapoda are represented by one specimen of the Family Belemnitidae d'Orbigny, 1845. A small rhyncholite has been isolated by F. M. Gradstein from Core 94.

The ammonites permit the recognition of upper Barremian (*Pulchellia*), the probably upper Valanginian (?*Paquiericeras*), and the Valanginian in general (*Neocomites*). Lamellaptychi are distributed all over the section examined. The oldest aptychus available is from Core 96. It represents a Lamellaptychus beyrichi (Plate 1, Fig. 19), which is a form that characteristically indicates the Tithonian. It also was found in about the same stratigraphic level in the section along the River Breggia in southern Switzerland (Fig. 1), as well as in the Apennines in Italy (Kälin et al., 1979, p. 748, fig. 11). It is interesting to note that aptychi are conspicuously concentrated within the interval here attributed to the Valanginian. This identification coincides with observations made in other holes drilled in the Atlantic, as well as in the Breggia section of southern Switzerland (Cantone Ticino), which represents a standard section of the Tethyan realm in Europe (Fig. 1).

PRESERVATION

Throughout the Blake-Bahama Formation the ammonites are flattened and preserved as impressions. The compression of the fossils probably resulted from compaction of the sediment. No evidence of the originally aragonitic test is preserved in any of the specimens. In contrast, aptychi consisting of calcite are preserved with all details, usually found in holes drilled in the Atlantic Ocean. Apparently the aragonitic shells of ammonites did not resist chemical destruction on the ocean floor, which suggests that ammonites conducted a pelagic mode of life. I tend to follow Schindewolf's ideas concerning the protective function of aptychi (1958, p. 35); contrary to these ideas is Lehmann's (1976) and Morton's (1981) interpretation that aptychi are the lower jaws of ammonites.

It is evident that objections can be raised against the proposed determinations of such deficiently preserved ammonites. Nevertheless, the taxonomy and derived stratigraphic assignments are in general agreement with the foraminifer and nannofossil stratigraphy, which supports the conclusions of this study.

From Core 75 within the interval assumed to be Valanginian, the ammonite genus ?*Paquiericeras* (Plate 1, Fig. 12A–B) may be of importance. In southwestern France it occurs in the *Saynoceras verrucosum* Zone of the late Valanginian.

As mentioned earlier, the interval considered to represent the Valanginian is distinguished by a conspicuous accumulation of aptychi. Forms especially important for correlation across the Atlantic are Lamellaptychus postbermudensis (Plate 1, Fig. 11) and Lamellaptychus challengeri (Fig. 1). So far those forms were thought to be restricted to the Atlantic. However, they also occur well developed within the interval assumed to represent the Valanginian in the Breggia section, but they are not known from the Neocomian of the western Carpathians (Gasiorowski, 1962).

[1] Sheridan, R. E., Gradstein, F. M., et al., *Init. Repts. DSDP*, 76: Washington (U.S. Govt. Printing Office).

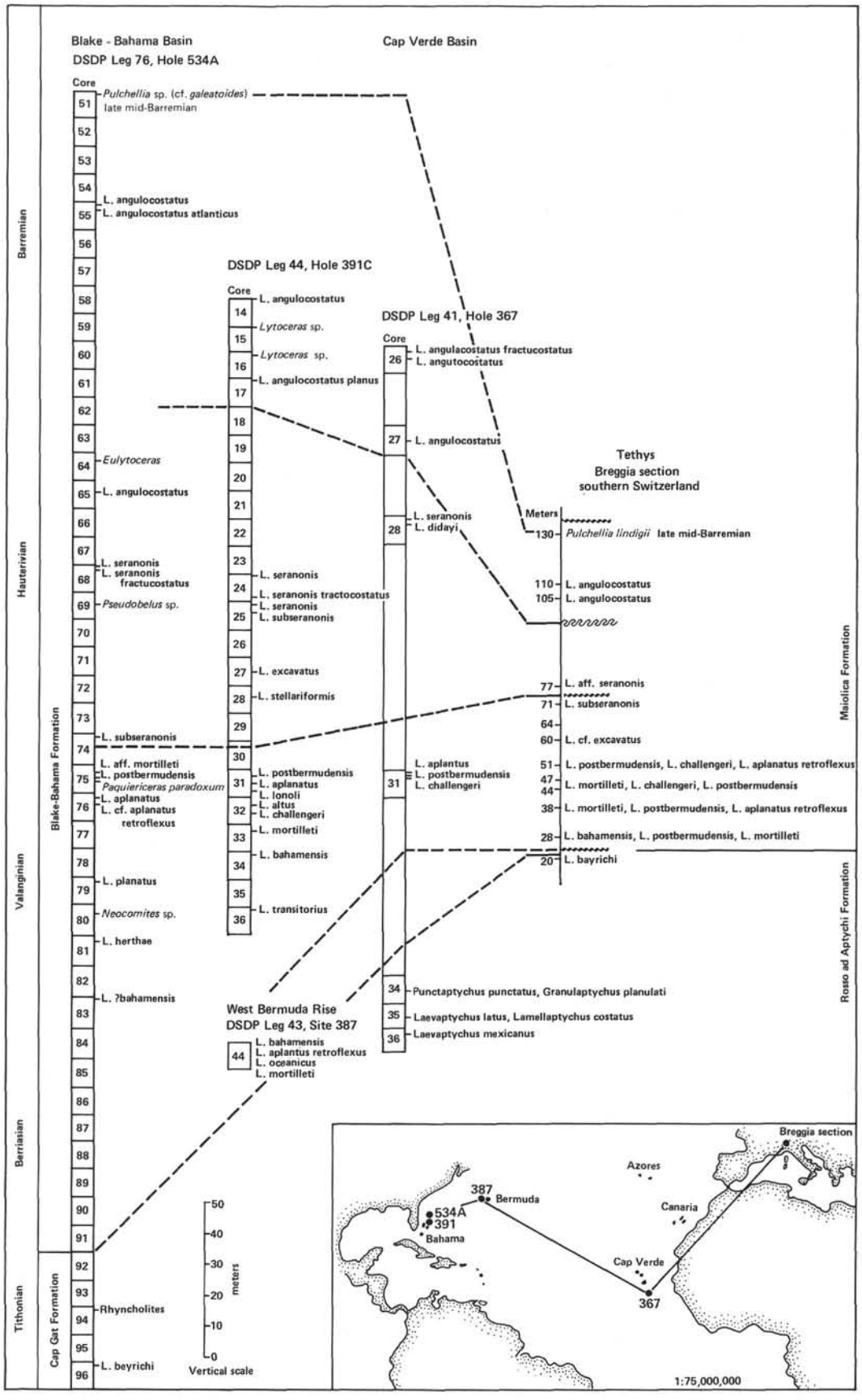

Figure 1. Correlation based on Cephalopoda from the Blake-Bahama Basin, across the Atlantic, to a Tethyan section in southern Switzerland. (L. = Lamellaptychus; ~~~ indicates interformational gaps due to subaquatic slidings.)

The Valanginian/Hauterivian boundary has been placed between Cores 73 and 74; thus this boundary is not far above Core 75, containing ?*Paquiericeras*. The boundary approximately coincides with the appearance in the Atlantic, as well as in the Breggia section, of Lamellaptychi belonging to the group of L. seranonis. According to Gasiorowski (1962, table 1, p. 22), L. seranonis first appears in the western Carpathians in the *Saynoceras verrucosum* Zone (upper Valanginian).

In Hole 534A, the position of the contact between the Hauterivian and Barremian based on the cephalopods remains doubtful. A specimen of *Eulytoceras* in Core 64 (Plate 1, Fig. 4A–C) is of little help in clarification, as its range extends from the Hauterivian to the Barremian. The boundary, as indicated on Figure 1, is placed provisionally within the range of Lamellaptychus angulocostatus, which roughly coincides with sections in the Carpathians (Gasiorowski, 1962, table 1, p. 22) where L. angulocostatus disappears in lower Barremian beds.

Of regional importance is the preservation of a small-sized specimen of *Pulchellia* (Plate 1, Fig. 1A–B) in Core 51. This specimen permits a reliable age assignment of late middle Barremian, and it moreover enables a safe correlation of Hole 534A with the Breggia River section in southern Switzerland, where very similar small-sized *Pulchellia* are known.

The results, obtained from only 19 samples collected from a sediment column of 400 m in Hole 534A, may be considered encouraging. Atlantic macrofossils, especially ammonites, seem to be of fundamental help in making age determinations. Everything should be done to obtain these macrofossils intact.

SYSTEMATIC DESCRIPTIONS

Superfamily HOPLITACEAE H. Douvillé, 1890
Family PULCHELLIIDAE Hyatt, 1903
Genus *PULCHELLIA* Uhlig, 1883

Pulchellia sp., cf. *P. galeatoides* (Karsten)
(Plate 1, Fig. 1A, B)

Ammonites galeatoides Karsten, 1886, plate 3, fig. 1, holotype.
Pulchellia cf. *P. galeatoides* (Karsten), Imlay, 1954, p. 665, plate 75, figs. 15, 16.
Heinzia (*Gerhardtia*) *galeatoides* (Karsten), Bürgl, 1956, p. 76, plate 17, figs. 1–5; plate 18, figs. 1–4; plate 19, fig. 1; plate 20, figs. 1, 3.

Sample 534A-51-1, 101–104 cm. A rather small-sized impression of a *Pulchellia* with a relatively wide umbilicus (about 27% of diameter, against 21.6–25.8%, according to Bürgl, 1956, p. 20). The ribs are broad and flat, ending in broad ventrolateral clavi. Interspaces are narrow. No lateral tuberculation is indicated.

Remarks. The present *Pulchellia* seems closely related to partly equally flattened and widely umbilicated specimens from the Barremian in the Breggia section (Fig. 1). Those were investigated by Rieber (1977, plate 2, fig. 7) and referred to *Pulchellia lindigii* (Karsten), a form characterized by small lateral tubercles. *P. lindigii* has been collected from the upper Maiolica Formation, where it is accompanied by *Karsteniceras, Simbirskites, Holcodiscus*, and the heteromorph *Anahamulina*.

In the epicontinental Cretaceous Basin of Colombia, complete sections of the Barremian furnishing abundant Pulchelliidae are exposed in the Cordillera Oriental. According to Bürgl (1956, p. 22), the lower part of the Barremian interval is dominated by Pulchelliidae with a very narrow umbilicus representing the genus *Niklesia*. Higher in the section, within the upper lower and middle Barremian, involute *Pulchellia* appear, as *P. hettneria* (Bürgl, 1956, plate 16). Evolute forms as *P. lindigii* and *P. galeatoides*, comparable to the present *Pulchellia*, are restricted to the mid-upper Barremian.

Areas closest to Site 534 where *Pulchellia galeatoides* also occurs are the Guajira Peninsula in Colombia (Renz, 1960) and the Northern Range of Trinidad (Imlay, 1954). A further interesting occurrence is at the Cap Verde Island of Meio, where Stahlecker (1934, p. 276, plate 12, figs. 3–5) showed remains of *Pulchellia*, together with *Leptoceras* and *Ancyloceras*. In the Barremian of the Province of Alicante in southern Spain, Pulchelliidae were described by Nicklés (1890).

The present *Pulchellia* might easily be confused with the broadly ribbed *Leymeriella pseudoregularis* Seitz, 1930, of the early Albian, from Austria. They are flattened in the same style as the *Pulchellia* shown here (Kennedy and Kollmann, 1979, p. 8, pl. 5, figs. 6–7, 10).

Superfamily LYTOCERATACEAE Neumayr, 1875
Family LYTOCERATIDAE Neumayr, 1875
Subfamily LYTOCERATINAE Neumayr, 1875
Genus *EULYTOCERAS* Spath, 1927

(Plate 1, Fig. 4A–C)

Sample 534A-64-3, 36–38 cm. A flattened specimen with approximately regularly and rather closely spaced, slightly concave fine ribs (Plate 1, Fig. 4C). The ribs are difficult to recognize on photographs (Plate 1, Fig. 4A–B). Periodically stronger ribs can be detected distinctly.

Remarks. *Eulytoceras* is known from the Valanginian and the Hauterivian. The present specifically undeterminable specimen is therefore not helpful in for precisely identifying the contact between the Hauterivian and the Barremian.

Superfamily PERISPHINCTACEAE Steinmann, 1890
Family CRASPEDITIDAE Spath, 1924
Subfamily GARNIERICERATINAE Spath, 1952
Genus *PAQUIERICERAS* Sayn, 1901

The specimen studied possesses no umbilical tuberculation and otherwise is smooth without any sculpture. We therefore can compare it with *Paquiericeras*.

?*Paquiericeras paradoxum* Sayn, 1901
(Plate 1, Fig. 12A, B)

Paquiericeras paradoxum Sayn, 1901, plate 2, fig. 15.
Paquiericeras paradoxum Sayn, Wright, 1957, p. L343, fig. 7a–b.
Paquiericeras paradoxum Sayn, Vermeulen, 1972, p. 42, plate 1, figs. 1–4.

Two species of *Paquiericeras* from the Basse-Alpes in southwestern France were described by Vermeulen (1972). They are *P. paradoxum* Sayn and *P. mourrei* Vermeulen, both of the late Valanginian (*Saynoceras verrucosum* Zone).

Sample 534A-75-5, 115–116 cm. The shell is evolute, and the umbilicus flat, reaching about 35% of diameter, in contrast to 41.9% for the specimen figured by Vermeulen. Flanks are not completely flattened but are still faintly convex, smooth without any sculpture. The fastigate venter "arrondi et pourvu d'une carène siphonal mouse," according to Vermeulen (1972), is faintly indicated. Between keel and flank a very flat groove is developed (Vermeulen, plate 1, figs. 1–4), which, however, is not visible on the present specimen. The most important feature of *Paquiericeras* is its particular suture line, not preserved on the specimen from the Atlantic. It is characterized by a lateral lobe separated from the external saddle by an additional smaller lobe (an adventitious lobe?). The suggested determination must therefore be provided with a question mark.

Remarks. The present specimen differs from the equally smooth oxycone *Saynella* Kilian, 1910 (lower Hauterivian) because of its considerably wider umbilicus. *Neolissoceras grasianum* (d'Orbigny), also unsculptured, ranges from the upper Tithonian to the Hauterivian. It is much more narrowly umbilicated than *Paquiericeras*.

Family BERRIASELLIDAE Spath, 1922
Subfamily NEOCOMITINAE Spath, 1924
Genus *NEOCOMITES* Uhlig, 1905

Neocomites sp.
(Plate 1, Fig. 16A, B)

Sample 534A-80-4, 27–29 cm. Because the core was cut into four segments, more than half of the specimens was lost. The conch is moderately evolute, and costation rather strong. Falcoid curved ribs

begin from small umbilical tubercles, distinctly recognizable. Bifurcations of ribs occur below as well as above the midside. Ventrolateral tubercles were lost when the core was cut.

Remarks. The present fragments seem to be most closely related to *Neocomites. Endemoceras* Thiermann, 1963 from the early Hauterivian in Germany and England shows a similar rib pattern (Kemper et al., 1981). A fragmental specimen, flattened in the same way as the present one, was collected by Bernoulli and Hottinger from the Valanginian of the Canarian Island Fuerteventura, at the locality Barranco de la Pena (D. Bernoulli, personal communication, 1982).

Order DECAPODA Leach, 1818
Suborder BELEMNOIDEA Naef, 1912
Family BELEMNITIDAE d'Orbigny, 1845
Genus *PSEUDOBELUS* de Blainville, 1827

***Pseudobelus* cf. *bipartitus* de Blainville, 1827**
(Plate 1, Fig. 8A–C)

Sample 534A-69-4, 18–20 cm. In respect to the stratification of the sediment, the preserved part of the rostrum, without the phragmocone, was in an oblique position. It therefore broke in seven fragments during compaction of the sediment. The surface of the hard calcareous rostrum is brownish colored and irregularly, flatly wrinkled. It is covered by a thin, soft layer of black, probably carbonaceous matter that shows a very fine, not very constant, longitudinal striation. The origin of this striation might be mechanical, due to friction along the surface of the rostrum during compaction of the sediment. The rostrum is characterized by two deeply impressed lateral grooves resulting in a bipartition. The grooves are wedge-shaped, with narrowly rounded edges, and probably were filled with a horny substance now carbonized. The horny mass probably was connected with the lateral fins. A very slightly indicated groove on the dorsal side of the rostrum is noticeable. It probably augments further in strength towards the phragmocone.

Probable age. Early Hauterivian, on the basis of aptychi and ammonites.

CORRELATIONS OF DEEP SEA DRILLING PROJECT HOLES IN THE ATLANTIC WITH A TETHYAN SECTION IN SWITZERLAND

In a general sense, international stage boundaries, using ammonites and aptychi, can so far not be established in holes drilled in the Atlantic. The main reason is the rare and patchy record of this type of macrofossil in oceanic deposits.

In Hole 534A, the Tithonian/Berriasian boundary may be considered one of the better-established time limits within the Jurassic–Cretaceous sequence (see Site 534 report, this volume). It is connected with an apparently regionally synchronous change in facies observable in the holes in the Atlantic, as well as at Tethyan surface sections in southern Europe (Bernoulli, 1972). The upper part of the reddish colored Cat Gap Formation of the Atlantic is correlative with the Rosso ad Aptychi Formation in southern Switzerland and in Italy. These formations generally are of the Late Jurassic. This interpretation, as mentioned, is supported by the occurrence of Lamellaptychus beyrichi in Core 96 in Hole 534A. This taxon occurs in a comparable stratigraphic position in the Breggia section in Switzerland (Fig. 1) and in the deep-water sediments of southeastern Tuscany in Italy (Kälin et al., 1979). The Maiolica Formation overlying Rosso ad Aptychi (Weissert, 1979) is thus time equivalent with the Blake-Bahama Formation overlying the Cat Gap Formation. This correlation is also well established by several ammonites and mainly by aptychi (Fig. 1).

From the interval assumed to represent the Berriasian, ammonites and aptychi are scattered. Mostly small fragments of Lamellaptychi were recovered from Hole 534A. The only assemblage composed of determinable forms was collected from DSDP Leg 43, Site 387, drilled on the West Bermuda Rise. From Core 49 at Site 387 a rich fauna was obtained. It therefore seems obvious that the Berriasian/Valanginian boundary, as tentatively indicated by Figure 1, is still open for discussions.

The interval considered to be Valanginian in Hole 534A ranges from about Core 74 to Core 82. This information is based on the ammonite genus *Neocomites* (Plate 1, Fig. 16A–B) in Core 80 and on ?*Paquiericeras* (Plate 1, Figure 12A–B) in Core 75. *Neocomites* occurs in the Valanginian as well as in the lower Hauterivian.

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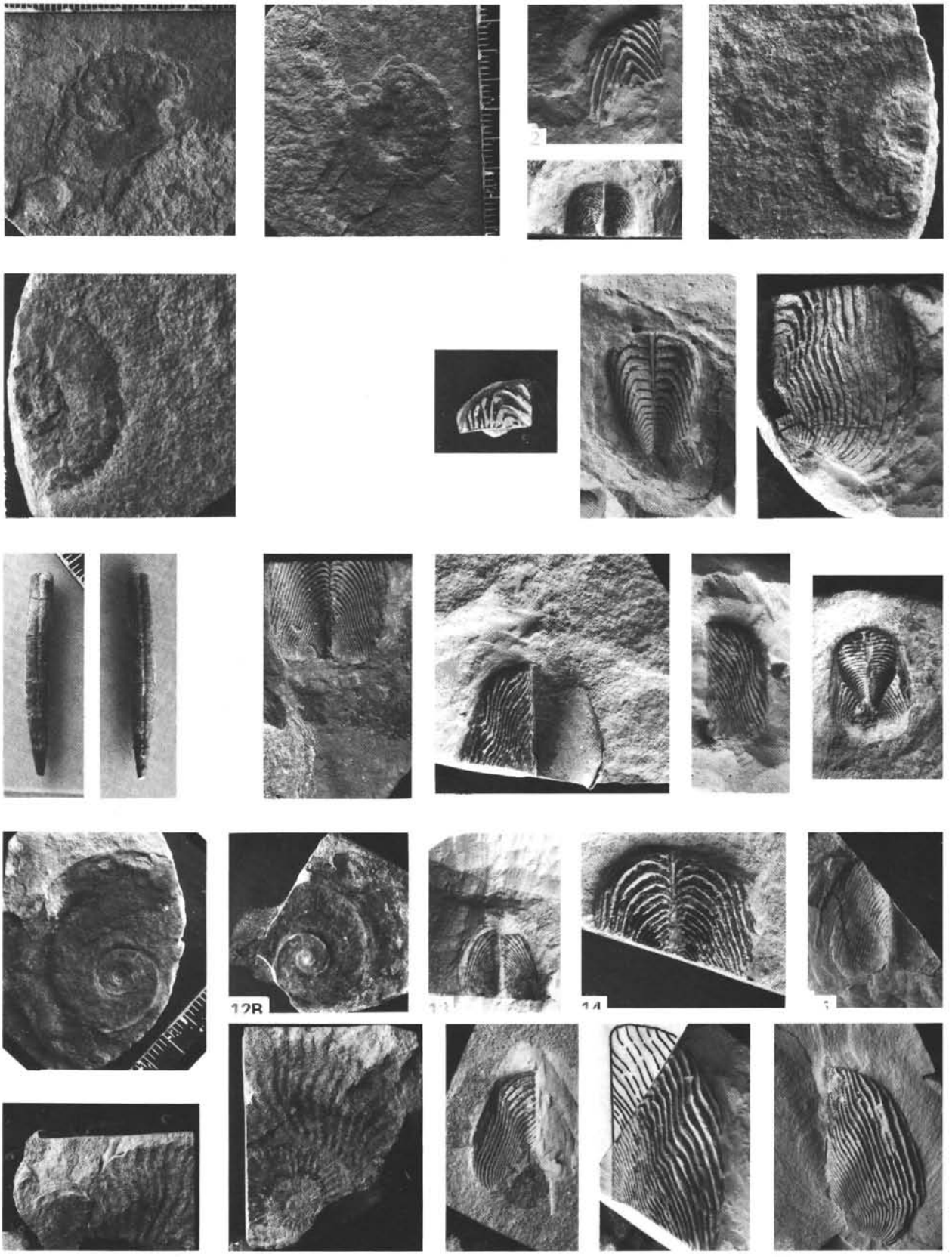
Plate 1. Hole 534A (see following page). **1–3.** Barremian. (1A–B) Sample 534A-51-1, 101–104 cm (J28817). *Pulchellia* sp., cf. *P. galeatoides* (Karsten) (A, positive; B, negative; magnification (×1). (2) Sample 534A-55-1, 43–45 cm (J28818), Lamellaptychus angulocostatus (Peters) (magnification ×2). (3) Sample 534A-55-2, 116–119 cm (J28819), Lamellaptychus angulocostatus atlanticus Trauth (×2). **4–9.** Hauterivian. (4A–C) Sample 534A-64-3, 36–38 cm (J28820). *Eulytoceras* sp. (×2). (5) Sample 534A-65-4, 78–80 cm (J28821). Lamellaptychus angulocostatus (Peters) (×2). (6) Sample 534A-68-1, 60–62 cm (J28822). Lamellaptychus seranonis (Coquand) (×2). (7) Sample 534A-68-2, 31–33 cm (J28823). Lamellaptychus seranonis fractocostatus Trauth (×2). (8A–B) Sample 534A-69-4, 18–20 cm (J28824). *Pseudobelus* sp. lateral views (×1). (9) Sample 534A-74-1, 25–26 cm (J28825). Lamellaptychus subseranonis Renz (×2). **10–18.** Valanginian. (10A–B) Sample 534A-75-3, 80–81 cm (J28826). Lamellaptychus aff. mortilleti (Pictet and Loriol) (×2). (11) Sample 534A-75-5, 49–51 cm (J28827). Lamellaptychus postbermudensis Renz (×2). (12A–B) Sample 534A-75-5, 115–116 cm (J28828). ?*Paquiericeras paradoxum* Sayn (A, positive; B, negative; ×1). (13) Sample 534A-76-2, 39–40 cm (J28829). Lamellaptychus aplanatus (Gillieron) (×2). (14) Sample 534A-76-4, 37–38 cm (J28830). Lamellaptychus aplanatus retroflexus Trauth (×2). (15) Sample 534A-79-1, 3–4 cm (J30351). Lamellaptychus aplanatus (Gillieron) (×2). (16A–B) Sample 534A-80-4, 27–29 cm (J30352). *Neocomites* sp. (A, negative; B, positive; ×1). (17) Sample 534A-81-4, 2–3 cm, (J30353). Lamellaptychus herthae (Winkler) (×2). (18) Sample 534A-83-1, 68–69 cm (J30354). Lamellaptychus ?bahamensis Renz, reconstruction (×2). **19.** Tithonian. Sample 534A-96-1, 106–107 cm (J30355). Lamellaptychus beyrichi (Oppel) (×2).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