

7. LOWER CRETACEOUS AMMONOIDEA FROM THE NORTHERN ATLANTIC, LEG 47B, HOLE 398D, DSDP

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INTRODUCTION

Hole 398D (40°57.6'N, 10°43.1'W) is under about 3900 meters of water, 90 kilometers from the western coast of the Iberian Peninsula and south of Vigo Seamount. Drilling penetrated the Paleocene-Cretaceous boundary at a sub-bottom depth of 800 meters and terminated at 1740 meters in Hauterivian limestone.

The Lower Cretaceous consists predominantly of a 720-meter body of uniform, dark gray claystones with thin turbidite interbeds. These claystones yielded 21 ammonites, 2 Lamellaptychi, 1 small gastropod, a fragment of *Inoceramus*, and some pieces of unidentified belemnites.

The ammonites are distinguishable into two assemblages: Albian and Barremian. The younger Albian congregation of ammonites ranges from about 1110 to 1365 meters in Cores 72 to 99 (Figure 1). This assemblage includes the upper Albian (although not proven on the basis of ammonite distribution), a recognizable middle Albian, and the *mammillatum* Zone of the lower Albian. Ammonites are not present that would indicate a *tardefurcata* Zone in the lowermost Albian. The older Barremian assemblage consists of only three ammonites collected between 1636 and 1663 meters in Cores 127 to 130.

A *Lamellaptychus angulocostatus* (Peters), recovered from 1720 meters in Core 136, indicates Hauterivian deposits.

ALBIAN

The ammonite fauna of the Albian consists of 18 specimens that represent 11 identifiable species and subspecies of the Families Phylloceratidae, Desmoceratidae, Douvilleceratidae and Lyelliceratidae. Among the Heteromorpha, the Hamitidae and Ptychoceratidae are represented (Figure 1). The identified species and subspecies are:

Phylloceras (*Hypophylloceras*) cf. *subalpinum* (d'Orbigny) Plate 1, Figure 4; *Phylloceras* (*Hypophylloceras*) cf. *seresitense tanit* Pervinquier (Plate 1, Figure 3); *Phylloceras* (*Hypophylloceras*) cf. *velledae velledae* (Michelin) (Plate 1, Figure 2); *Phylloceras* (*Hypophylloceras*) cf. *aphrodite* Fallot and Termier (Plate 1, Figure 1); *Beudanticeras* sp. (Plate 2, Figure 3); *Beudanticeras newtoni* Casey (Plate 2, Figure 2); *Parasilesites kilianiformis* (Fallot) (Plate 2, Figure 1); *Lyelliceras lyelli* (d'Orbigny) (Plate 2, Figure 5); *Hypacanthoplites milletianus* (d'Orbigny) (Plate 2, Figure 4); *Hamites attenuatus* J. Sowerby (Plate 2, Figure 6); and *Ptychoceras* cf. *laeve* Matheron (Plate 2, Figure 7).

With 8 specimens, the Phylloceratidae dominate the assemblage and represent 44 per cent of the total Albian ammonites collected. The Desmoceratidae are second in abundance, with 5 specimens representing 28 per cent. The re-

Stage	Zone	Subzone	Core	Section Interval (cm)	Specimen	
UPPER ALBIAN	(Not proven by ammonites)			72	1, 0-2	<i>Beudanticeras</i> sp., small fragment with segment of suture, probably still Albian
				73		
				74		
				75		
				76		
				77	1, 148-150	Small fragments of <i>Inoceramus</i>
				78	CC, 0-2	<i>Phylloceras</i> sp., test fragments
				79		
				80		
				81		
				82		
				MIDDLE ALBIAN		
84	2, 125-127	<i>Lyelliceras</i> sp., poorly preserved fragment				
85						
86						
87						
88	5, 12-15	<i>Lyelliceras lyelli</i> (d'Orbigny)				
88	6, 41-42	<i>Parasilesites kilianiformis</i> (Fallot)				
88	1, 148-150	<i>Phylloceras</i> (<i>Hypophylloceras</i>)? <i>subalpinum</i> (d'Orb.)				
89						
90	1, 70-73	<i>Phylloceras</i> (<i>Hypophylloceras</i>) cf. <i>subalpinum</i> (d'Orb.)				
90	3, 13	<i>Beudanticeras</i> sp., strongly compressed				
90	4, 65-67	<i>Phylloceras</i> (<i>Hypophylloceras</i>) cf. <i>aphrodite</i> Fallot and Termier, suture				
LOWER ALBIAN				92	1, 104	<i>Ptychoceras</i> cf. <i>laeve</i> Matheron, initial and second shaft
				93	3, 52	<i>Phylloceras</i> sp., test fragments
				93	3, 146	<i>Phylloceras</i> sp., test fragments
				94		
				95	4, 99-100	<i>Hypacanthoplites milletianus</i> (d'Orbigny)
				95	5, 77-78	<i>Hamites attenuatus</i> J. Sowerby
				95	1, 117-119	<i>Phylloceras</i> (<i>Hypophylloceras</i>) cf. <i>velledae velledae</i> (Michelin), suture
				96	1, 123-128	<i>Phylloceras</i> (<i>Hypophylloceras</i>) cf. <i>seresitense tanit</i> Pervinquier
				97		
				98		
99	1, 54-55	<i>Beudanticeras newtoni</i> Casey, with part of suture				

Figure 1. Distribution of ammonites in the Albian sediments of Leg 47B, Hole 398D.

maining five specimens are distributed among the genera *Hypacanthoplites*, *Lyelliceras*, *Hamites*, and *Ptychoceras* (28 per cent of the total).

Upper Albian

Within the interval of Cores 72 to 82 (1120 to 1220 m), specifically unidentifiable fragments of tests of *Phylloceras* sp. (Sample 77-CC, 0-2 cm) and fragments showing segments of the suture indicating a *Beudanticeras* (Sample 73-1, 0-2 cm) are present. These remains do not permit reliable age determinations. The presence of *Beudanticeras* at the top of Core 73 suggests, however, an Albian age for the interval; according to its position in the section, these sediments are considered upper Albian.

Middle Albian

The middle Albian ammonites are better preserved and allow more accurate age determinations. This interval is represented by Cores 82 to 91 (1220 to 1310 m). Within the middle Albian, the following three ammonite zones are established: the *Euhoplites lautus*, the *Euhoplites loricatus* and the *Hoplites dentatus* zones (Owen, 1971). The ammonites in our samples are confined to the *dentatus* Zone, which again is subdivided into three subzones. One of these, the *Lyelli* Subzone (Figure 1), is ascertained in Core 88 (1270 m) by the presence of a relatively well preserved specimen of *Lyelliceras lyelli* (d'Orbigny). This specimen is considered reliable evidence of middle Albian deposits. The middle Albian-lower Albian boundary seems fairly restricted between Cores 91 and 92 (1309 m).

Lower Albian

The established ammonite zones of the lower Albian are the *Douvilleiceras mammillatum* above, and the *Leymeriella tardefurcata*, below. Only the *mammillatum* Zone, which is subdivided into four subzones, is reliably represented in Hole 398D. The age-indicating ammonite of importance is *Hypacanthoplites milletianus* (d'Orbigny) derived from Sample 95-4, 99-100 cm (about 1340 m). About 25 meters deeper, *Beudanticeras newtoni* Casey occurs in Sample 99-1, 54-55 cm (1365 m). In southern England, this species attains its greatest frequency within the *floridum* Subzone (the third of the four succeeding subzones) of the *mammillatum* Zone.

Only a minute share of the Albian ammonite fauna in this area was recovered from Hole 398D. Abundant Phylloceratidae and Desmoceratidae, and the absence of strongly ornamented Hoplitidae suggest an open basin Albian environment. Comparable depositional environments are known from Mallorca (Fallot, 1910, 1920) and from southern Spain in the Alicante region, where the faunal character is also dominated by the Phylloceratina. Similar assemblages composed of *Lyelliceras*, abundant *Beudanticeras*, and *Tetragonites* occur in the Andean Geosyncline, especially in the Cordillera del Interior of Venezuela.

APTIAN

No Aptian ammonites were recognized at Hole 398D. And as yet undescribed fragmentary Lamellaptychus from Sample 105-3, 84 cm (1423 m) is the only larger fossil collected (Plate 2, Figure 8). Evaluation of the importance of this find requires comparison with finds from future drilling.

BARREMIAN

Three strongly compressed Barremian ammonites, also with their tests preserved, occurred between Cores 127 and 130 (1636 to 1663 m), 243 meters below the deepest Albian ammonite. The genus *Barremites* is represented by two specimens, which are accompanied by a juvenile *Protetragonites*; all are specifically unidentifiable. *Barremites* is widely distributed between southern England and northern Africa, and several species from the Barremian of the Alicante region in southern Spain are described by Lillo Bevia (1975 a,b).

HAUTERIVIAN

The presence of Hauterivian deposits is suggested by a single, favorably preserved *Lamellaptychus angulocostatus* (Peters). This specimen (Plate 2, Figure 9) occurs in Core 136, 22.5 meters above the bottom of the hole. In the North Atlantic, *L. angulocostatus* has been recorded in several DSDP holes: from Hole 105 (Core 18, pl. 4, fig. 1-5) in the Hatteras Abyssal Plain, Leg 11 (Renz, 1972); Hole 367 (Core 26, pl. 1, fig. 34, 35; Core 27, pl. 2, fig. 1-4) in the Cape Verde Basin, Leg 41 (Renz, 1977); and from Hole 391C (Cores 14 to 17, pl. 1, fig. 16, 17) in the Blake-Bahama Basin, Leg 44 (Renz, in press).

SYSTEMATIC DESCRIPTIONS

The ammonites were received in June 1976 from Jacques Sigal who collected them on-board ship during Leg 47B. The material was still moist, and disintegrated rapidly when unpacked. Measures had to be taken immediately to avoid further disintegration of the claystone, separation of the fossils from the matrix, and breakage of the ammonite tests.

Without exception, all ammonites had their tests well preserved and little diagenetic alteration occurred. The composition of test material from a *Hamites attenuatus* J. Sowerby (Sample 95-5, 77-78 cm) was analyzed by X-ray diffraction by S. Graeser, mineralogist of the Museum. The Debye-Scherrer diagram clearly shows that the test material is absolutely identical with aragonite. The appearance of the test is mother of pearl-like, brilliant light brown, and without visible traces of original color.

This type of preservation is typical for shale-clay sequences, where diagenetic exchange of shell material by solution is reduced to a minimum. During sinking to the sea bottom, only the thin outer layer of the test, containing color pigment, was removed. The aragonite of the conch was not affected by solution, nor was it transformed into calcite. We assume that the recovered ammonites did not live near the bottom of the sea, where they presently form part of a death community (thanatocoenosis). The conchs were probably rapidly buried by shale or turbidite flows. According to Friedman (1965), pteropod shells composed of aragonite apparently dissolve at a water depth of about 3500 meters. We might assume that the water depth during the Albian at Site 398D was considerably above this depth.

The internal structure of the test is clearly observable on several specimens, especially Phylloceratidae. On lamellae forming the outer layer of the test, spirally arranged bends displaying feather structures have been occasionally noticed (Plate 1, Figure 1a). The prismatically structured thin inner layer is generally well preserved.

Most of the ammonite conchs have been crushed and flattened by compaction of the sediment. Some tests are broken into innumerable small fragments (*Ptychoceras* sp., Plate 2, Figure 7); some are strongly bent, especially less resistant phragmocones (? *Protetragonites*, Plate 1, Figure 5). The venters of thin-shelled *Phylloceras* and *Beudanticeras* are the most strongly affected. Nevertheless, suture lines sometimes remain recognizable and were freed by removing the test fragments. This was done on several *Phylloceras* (Plate 1, Figure 4), as well as *Barremites* (Plate 1, Figure 7), which otherwise never could have been determined. Fortunately, some ornamented species as *Lyelliceras lyelli* (d'Orbigny) and *Hypacanthoplites milletianus* (d'Orbigny), which are more resistant to compaction, are less deformed and more readily identified.

Family PHYLLOCERATIDAE Zittel, 1884

Genus PHYLLOCERAS Süsser, 1865

Subgenus HYPOPHYLLOCERAS Salfeld, 1924

The subdivisions of the subgenus *Hypophylloceras* are based on the development of the suture lines as established by Wiedmann (1963).

Specific determinations of the specimens remain tentative; they are based mainly on the suture and the sculpture as determinable by the stage of preservation. Whorl sections, however, could not be considered because of the deformation of the conchs.

Group of Phylloceras (Hypophylloceras) thetis (d'Orbigny)

This group is distinguished by a diphyloid pattern of the two main saddles through all stages of their development (Wiedmann, 1963, p. 173).

Phylloceras (Hypophylloceras) cf. aphrodite Fallot and Termier

(Plate 1, Figure 1a, 1b)

1923 *Phylloceras aphrodite* Fallot and Termier, p. 25, pl. 2, fig. 5-7.1963 *Phylloceras (Hypophylloceras) aphrodite* Fallot and Termier, Wiedmann, p. 184, pl. 18, fig. 4-6; pl. 20, fig. 1; text-fig. 40.1975 *Phylloceras (Hypophylloceras) aphrodite* Fallot and Termier, Lillo Bevia, p. 398, pl. 2, fig. 1, 2.**Neotype:** Wiedmann, 1962, pl. 16, fig. 5; 1963, pl. 18, fig. 4.

Sample 90-4, 65-67 cm is a compressed fragment, representing the end of the phragmocon (indicated by arrow) of a fairly large specimen (diameter after reconstruction, about 40 mm). The diameter of the umbilicus is 3.2 mm (0.08), compared with 0.07 of the neotype with a diameter of 50 mm. Two of the constrictions directed adorally are slightly recognizable. No clear riblets, but faint growth lines are preserved on the external side of the whorl. Suture shows clear diphyloid saddles, which coincide in detail with those of *Ph. aphrodite* as shown by Wiedmann (1963, p. 185, fig. 40).

The specimen was collected 17.5 meters below *Lyelliceras lyelli*. Its age, therefore, is early middle Albian.

Ph. aphrodite is known from Mallorca and the Alicante region, from France (Breistroffer, 1947), and from Sinai (Mahmoud, 1955, pl. 5, fig. 1).

Phylloceras (Hypophylloceras) cf. subalpinum (d'Orbigny)

(Plate 1, Figures 4a, 4b)

1963 *Phylloceras (Hypophylloceras) subalpinum* d'Orbigny, Wiedmann, p. 194.

Sample 90-1, 70-73 cm, the largest *Phylloceras* of the collection, is best comparable with *Ph. (H.) subalpinum*. The latter can be distinguished into two subspecies: *Ph. (H.) subalpinum subalpinum* d'Orbigny characterized by a subtriangular whorl section, and *Ph. (H.) subalpinum ellipticum* Kossmat, characterized by an elliptical whorl section. The features of these subspecies are otherwise identical. Because of compression, it is not possible to attribute the present specimen to one of the two subspecies.

The specific features exposed on the test are radial, sigmoidal, broad, flat folds, and closely spaced growth lines passing towards the venter into faint riblets. By removing part of the test along the end of the phragmocon, the next inner whorl appeared immediately beneath, exposing part of the diphyloid suture line. The preserved portion of the specimen coincides satisfactorily with the suture of *Ph. (H.) subalpinum subalpinum* d'Orbigny from Mallorca, drawn by Wiedmann (1963, p. 196, fig. 45).

The specimen was collected 6 meters above *Ph. (H.) cf. aphrodite* and 12.5 meters below *Lyelliceras lyelli*; the interval, therefore is middle Albian.

Sample 89-1, 184-150 cm yields the badly crushed remains of test showing parts of diphyloid saddles, similar to those on *Ph. (H.) subalpinum subalpinum*.

Group of Phylloceras (Hypophylloceras) velleidae (Michelin)

The suture is characterized by a diphyloid saddle L/E and a tetraphylloid saddle L/U₂ (Wiedmann, 1963, p. 173, 204).

Phylloceras (Hypophylloceras) cf. velleidae velleidae (Michelin)

(Plate 1, Figures 2a, b)

1963 *Phylloceras (Hypophylloceras) velleidae velleidae* (Mich.), Wiedmann, p. 209, pl. 11, fig. 1; pl. 13, fig. 4; pl. 21, fig. 4; suture, text-fig. 49.

Neotype: *Ammonites velleidae* Michelin, in d'Orbigny, 1841, pl. 82, fig. 1, 2.

Sample 96-1, 117-119 cm is a rather small, somewhat less compressed specimen with its venter partially preserved. This specimen is similar to a juvenile *Ph. (H.) velleidae velleidae* as figured by Wiedmann (1963, pl. 21, fig. 4). A reconstruction of the whorl section was attempted with the help of a cast of the preserved impression. The resulting measurements are: diameter, 23 mm; whorl height, 14 mm (0.60); whorl width, 7 mm (0.30); Ww/Wh = 0.50 compared with 0.62 for the neotype (Wiedmann, 1963, p. 212).

The whorl section is high oval, the venter is broadly rounded, and the flanks are weakly arched with their maximal width slightly below the middle of the flank. The umbilicus is very narrow and funnel shaped. The test is covered by faint growth lines, developing into riblets towards the venter. The suture is incompletely preserved. The saddle L/U₂ is beginning to be tetraphylloid (compare Weidmann, 1963, fig. 49a, p. 211).

The specimen was extracted 4.7 meters below *Hypacanthoplites millettianus* d'Orbigny, which indicates early Albian (*mammillatum* Zone).

Group of Phylloceras (Hypophylloceras) seresitense Pervinquieré

The suture of this group is characterized by a tetraphylloid saddle L/E as well as L/U₂.

Phylloceras (Hypophylloceras) cf. seresitense tanit Pervinquieré

(Plate 1, Figures 3a, 3b)

1963 *Phylloceras (Hypophylloceras) seresitense tanit* Perv., Wiedmann, p. 226, pl. 21, fig. 2, 3; suture, text-fig. 54a.1968 *Phylloceras (Hypophylloceras) seresitense tanit* Perv., Wiedmann and Dieni, p. 26, pl. 1, fig. 6; pl. 3, fig. 1.**Holotype:** *Phylloceras tanit* Pervinquieré, 1907, text-fig. 5; pl. 3, fig. 6, 7.

Sample 96-1, 123-128 cm yields a specimen with a diameter of 44 mm which is one of the better-preserved ammonites of the collection. Its suture is too indistinctly preserved to be reproduced, so the determination had to be based on morphological features. By its considerably wider umbilicus (Plate 1, Figure 3b) of 4.6 mm (0.10), this specimen differs from *Ph. seresitense seresitense* Pervinquieré. The ornamentation on the test is well preserved, and characterized by bi-convex growth lines developing into prominent riblets towards the venter. The present specimen closely resembles those figured by Wiedmann (1963, p. 228, fig. 54b) from Mallorca, and by Wiedmann and Dieni (1968, pl. 1, fig. 6) from Sardinia.

Ph. (H.) seresitense tanit is widely found in western Europe and occurs in North Africa, Madagascar, India, and Mexico (Böse, 1923, p. 119, pl. 7, fig. 15-17).

Family PROTETRAGONITIDAE Spath, 1927

(Plate 1, Figure 5)

Sample 129-7, 18-20 cm yields a small Barremian specimen (diameter of 18 mm), possibly related to the genus *Protetragonites*, that was found in the vicinity of *Barremites* sp. Except for faint growth lines on the test, neither sculpture (constrictions) nor signs of the suture could be detected.

Family DESMOCERATIDAE Zittel, 1895**Subfamily EODESMOCERATINAE Wright, 1955**

Genus BARREMITES Kilian, 1913

Barremites sp.

(Plate 1, Figures 7a, 7b.)

Sample 128-1, 61-65 cm provided the test of a flattened quarter whorl that is broken into numerous fragments. Removing the test revealed part of the suture and facilitated a generic determination (see arrow). Reconstruction of the whorl section along the external side of the core is doubtful, but it is obviously elongate-ovate. The flank seems gently arched (based on larger single-test fragments), and the umbilical wall falls off steeply towards an involute umbilicus. Except for sinuous growth lines on the test, no signs of sculpture (constrictions) are detectable. The suture satisfactorily coincides with that drawn by Roman (1938, p. 408, fig. 388) of a *Barremites*.

The genus occurs worldwide. The nearest occurrence to Site 398 is found in the Alicante region of southern Spain (Lillo Bevia, 1975 a, b).

Barremites sp.
(Plate 1, Figure 6)

Sample 130-3, 105 cm yields a flattened specimen that, except for its eccentric umbilicus, is comparable with the fragment previously described. The sculpture is restricted to sinuously bent growth lines.

Subfamily PUZOSIINAE Spath, 1922

Genus PARASILESTIES Imlay, 1959

Parasilesites kilianiformis (Fallot)
(Plate 2, Figures 1a, 1b)

- 1910 *Puzosia nolani* var. *kilianiformis* Fallot, p. 26, pl. 1, fig. 5.
1920 *Puzosia nolani* var. *kilianiformis* Fallot, p. 46.
1947 *Silesites kilianiformis* Fallot, Breistroffer, p. 62.
1957 *Silesites nolani* var. *kilianiformis* (Fallot), Almela and De La Revilla, p. 28, pl. 7, fig. 3.
1968 *Parasilesites kilianiformis* (Fallot), Wiedmann and Dieni, p. 124, pl. 10, fig. 7; suture, text-fig. 79, p. 125.

Holotype: P. Fallot, 1910, pl. 1, fig. 5a, b.

Sample 88-6, 41-42 cm contains a small compressed specimen with a diameter of 22 mm and an umbilicus of 8 mm (0.36). The five broad, radial, periodic constrictions per whorl are somewhat more closely spaced than those on the well-preserved specimen from Sardinia with four constrictions per whorl. The fine ribs between the constrictions are also well exposed on the impression (Plate 2, Figure 1b).

The specimen was collected close to *Lyelliceras lyelli*, which indicates an early middle Albian age (*dentatus* Zone).

The species *Parasilesites bullatus* Imlay (1959, p. 184, pl. 29, fig. 1-8; 1960, pl. 18, fig. 1-8) from the Albian of Alaska shows distinctly more constrictions per whorl than this specimen.

Subfamily BEUDANTICERATINA Breistroffer, 1953

Genus BEUDANTICERAS Hitzel, 1905

Four ammonites referred to *Beudanticeras* are distributed over the Albian interval, indicating a rich development of the genus in this claystone environment. Besides *Beudanticeras newtoni* Casey, the preservation is so poor that accurate determinations are not possible.

Sample 73-1, 0-2 cm has a fragment with the suture preserved. Considered a *Beudanticeras*, this find is the uppermost ammonite occurrence at this site.

Beudanticeras sp.
(Plate 2, Figure 3)

Sample 84-1, 68-70 cm yields a fragment of a body chamber that appears to be a large *Beudanticeras* (whorl height of about 35 mm). The ornament consists of well-marked, falcoid growth lines, and one of the broad, prominent, falcoid constrictions characterizing the body chamber of adult specimens. The small, irregular, subspherical deepening adorally from the constriction probably were the result of boring organism.

The fragment was extracted in the vicinity of a *Lyelliceras* and, therefore, is considered middle Albian (*dentatus* Zone).

Sample 90-3, 13 cm contains a flattened *Beudanticeras* (diameter 24 mm) that was sampled 15 meters below *Lyelliceras lyelli*, thus indicating the *lyelli* Subzone of the middle Albian. The septa are partly crushed into a brecciated mass such that only fragments of the suture are recognizable.

Beudanticeras newtoni Casey
(Plate 2, Figures 2a, 2b)

1961 *Beudanticeras newtoni* Casey, p. 147, pl. 26, fig. 12; pl. 27, fig. 2-5; pl. 28, fig. 7, 8; pl. 29, fig. 2; text-fig. 47a-b, c, e, f.

Holotype: Casey, 1961, text-fig. 47a, b, p. 150.

Sample 99-1, 54-55 cm contains a slightly compressed ammonite that is best comparable to the *Beudanticeras newtoni* figured by Casey (1961, pl. 29, fig. 2). The latter specimen occurs in the *mammillatum* Zone (nodule-beds, *floridum* Subzone, Squerrie's main pit, Westerham, Kent).

With a diameter after reconstruction of 32 mm, a whorl height of 15.2 mm (0.47), and an umbilicus of 6.3 mm (0.20), this find compares well with the measurements obtained by Casey. The whorl section is highly elliptical and widest toward the inner quarter of the flank. The umbilical rim is sharply expressed, the umbilical wall falls off steeply toward the fairly narrow

umbilicus, and the umbilical spiral is distinctly eccentric. Sculpture on test consists of fine growth lines and widely spaced, broad, falciform ridges increasing in strength adorally. The suture was only partially freed to avoid destruction of the test.

Beudanticeras newtoni is the oldest ammonite recovered from the Albian within this hole. Occurring 31 meters below *Hypacanthoplites milletianus* (d'Orbigny) of the lower Albian, this specimen might indicate the *raulianus* to *floridum* subzones, where *B. newtoni* reaches its maximum abundance in southern England (Casey, 1961, p. 152).

Family DOUVILLEICERATIDAE Parona and Bonarelli, 1897

Genus HYPACANTHOPLITES Spath, 1923

Hypacanthoplites milletianus (d'Orbigny)
(Plate 2, Figures 4a, 4b, 4c)

- 1841 *Ammonites milletianus* d'Orbigny, p. 263, pl. 77, fig. 1, 2.
1947 *Hypacanthoplites milletianus* d'Orbigny, Breistroffer, p. 40.
1964 *Hypacanthoplites milletianus* (d'Orbigny), Casey, p. 433, p. 40, pl. 73, fig. 7a-b; text-fig. 160.

Lectotype: d'Orbigny, 1841, pl. 77, fig. 1, 2; Casey, 1965, text-fig. 160f, g.

Sample 95-4, 99-100 cm contains a favorably preserved specimen showing a juvenile whorl, as well as a fragment of the adult whorl that is oblique to the bedding and covers part of the juvenile whorl. The whorls resisted compaction because of this configuration.

Ribs on the juvenile whorl are alternately long and short and faintly sinuous. The longer ones begin from pronounced umbilical tubercles, from which a branching of the ribs also can occur. The adult whorl fragment is subquadrate in section. The specimen is slightly higher than wide, with maximum thickness just above the umbilicus (Plate 2, Figure 4c). The flanks are weakly convex, converging towards a flat venter. This specimen exhibits coarse and rigid costation, and alternately long and short ribs. The short ribs begin within the dorsal third of the flank.

Except for its coarser costation, the specimen is very similar to *Hypacanthoplites trivialis* Breistroffer (1947, p. 84).

H. milletianus seems to be restricted to the early Albian (compare Casey, 1964, p. 435).

Family LYELLICERATIDAE Spath, 1921

Genus LYELLICERAS Spath, 1921

Lyelliceras lyelli (d'Orbigny)
(Plate 2, Figures 5a, 5b)

1897 *Acanthoceras lyelli* Deshayes (in Leymerie, 1842), Parona and Bonarelli, p. 96, pl. 13, fig. 7-12.

1931 *Lyelliceras lyelli* (d'Orbigny), Spath, p. 316, pl. 32, fig. 9, 12, 13; text-fig. 103.

1971 *Lyelliceras lyelli* (d'Orbigny), Owen, pl. 2, fig. 2a, b.

Lectotype: d'Orbigny, 1841, pl. 74, fig. 4.

Sample 88-5, 12-15 cm yields a conch filled with a hard aggregate of pyrite crystals formed prior to compression, thereby enabling the fossil to resist compaction. We removed the pyrite and made a cast (Plate 2, Figure 5a). The venter with syphonal tubercles is not preserved. *Lyelliceras pseudolyelli* Parona and Bonarelli (1897, p. 99, pl. 14, fig. 1, 2) differs from this species by wider spaced ribs and alternating tubercles on the venter.

L. lyelli indicates the *lyelli* Subzone of the *dentatus* Zone and, therefore, is of considerable value for a subdivision of the Albian interval.

Lyelliceras is widely distributed in western Europe and northern Africa, as well as in the Andean Geosyncline: Peru (Schlagintweit, 1911, p. 87) Colombia, Venezuela (Guillaume et al., 1972, p. 1653), and Mexico (Böse, 1923, p. 160, pl. 11, fig. 1-3).

Lyelliceras sp.

Sample 84-2, 125-127 cm contains the dorsal half of a larger whorl fragment. Impressions of syphonal tubercles from the next inner whorl are visible.

Family HAMITIDAE Hyatt, 1900

Genus HAMITES Parkinson, 1811

Hamites (Hamites) attenuatus J. Sowerby
(Plate 2, Figures 6a, 6b)

1941 *Hamites attenuatus* J. Sowerby, Spath, p. 607, pl. 67, fig. 1-13, 19; text-fig. 218.

Lectotype: J. Sowerby, 1814, pl. 61, fig. 4, refigured by Spath, 1941, text-fig. 218.

Sample 95-5, 77-78 cm yields a compressed but otherwise favorably preserved example of this species, common in the middle Albian (*dentatus* and *lautus* Zones) of southern England.

According to less compressed parts of the test, the whorl section seems to have been broadly oval. The obliquity of the ribbing is less pronounced than on specimens from England reproduced by Spath (1941).

The stratigraphical position of *H. attenuatus*, close to *Hypacanthoplites milletianus* (d'Orbigny) and 56 meters below *Lyelliceras lyelli* (d'Orbigny) of the middle Albian, indicates a late early Albian date for this specimen (*mammillatum* Zone).

Family PTYCHOCERATIDAE Meek, 1876

Genus PTYCHOCERAS d'Orbigny, 1842

Ptychoceras cf. *laeve* Matheron

(Plate 2, Figures 7a-7c)

Holotype: P. Matheron, 1842, p. 338, pl. 41, fig. 3.

Sample 93-1, 104 cm yields this small fragment that is comparable with the holotype of *P. laeve* from the upper Aptian (Gargasien) from Cassis-sur-Mer (Bouches-du-Rhône) in southern France (Breistroffer, 1951, p. 47). The hook between the initial and second shaft is present. The initial shaft leans closely against the second shaft, but whether it is pressed into the dorsum of the second shaft cannot be ascertained. The surface of the test is smooth, traces of constrictions or ribs cannot be detected. The suture is characterized by simple bifid lobes and saddles.

Busnardo (1957, p. 57) mentions *P. laeve* from lower Albian marls with *Hypacanthoplites* in the Constantine region in Algeria.

Ptychoceras laeve hamaimensis has been described by Pervinquier (1907, p. 90, pl. 4, fig. 5-6) from the lower Albian of Tunisia, where it occurs with *Hypacanthoplites*. This subspecies possesses constrictions on the second shaft and may be related with the present specimen.

Ptychoceras mazapilense (Burckhardt) from the Albian of Zacatecas in Mexico (Böse, 1923, p. 137, pl. 10, fig. 1-8) is also small, and seems to be related to the present species.

From the Serranía del Interior in Eastern Venezuela, *P. laeve* has been identified from the upper Aptian *Chelonicerases martini* Zone (Guillaume et al., 1972, p. 1653).

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PLATE 1

- Figure 1a Sample 90-4, 65-67 cm. *Phylloceras* (*Hypophylloceras*) cf. *aphrodite* Fallot and Termier, J 28237. Arrow indicates end of phragmocon. Middle Albian. 1.5×.
- Figure 1b Suture at a whorl height of 20 to 22 mm. 3×.
- Figure 2a Sample 96-1, 117-119 cm. *Phylloceras* (*Hypophylloceras*) cf. *velledae velledae* (Michelin), J 28238. Albian. 1.5×.
- Figure 2b Fragment of suture at a whorl height of about 8 mm. 5×.
- Figure 3a Sample 96-1, 123 to 128 cm. *Phylloceras* (*Hypophylloceras*) cf. *seresitense tanit* Pervinqui re, J 28239. Suture indistinct. Lower Albian. 1.5×.
- Figure 3b Impression clearly showing the open umbilicus. 1.5×.
- Figure 4a Sample 90-1, 70 to 73 cm. *Phylloceras* (*Hypophylloceras*) cf. *subalpinum* (d'Orbigny), J. 28240. The flat folds on the test are exposed on the fragment to the right, representing the end of the phragmocon, which overlaps on the fragment to the left (body chamber). Middle Albian. 1.5×.
- Figure 4b Suture on the next inner whorl of the fragment to the left (arrow), at a whorl height of about 15 mm. 5×.
- Figure 5 Sample 129-7, 18 to 20 cm. ? *Protetragonites* sp., J 28241. Barremian. 1.5×.
- Figure 6 Sample 130-3, 105 cm. *Flattened Barremites* sp., J 28242. Barremian. 1.5×.
- Figure 7a Sample 128-1, 61 to 65 cm. *Barremites* sp., J 28243. Steep umbilical wall is prominent. Barremian. 1.5×.
- Figure 7b Suture (arrow) has been freed by removing crushed test fragments. Whorl height about 14 mm. 5×.

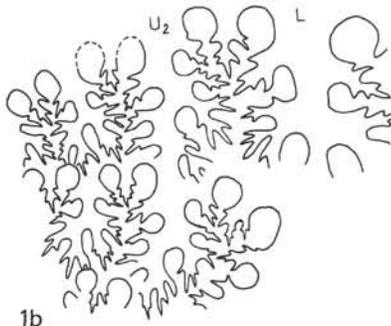
PLATE 1



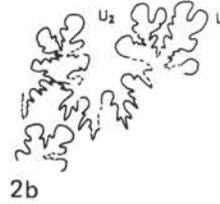
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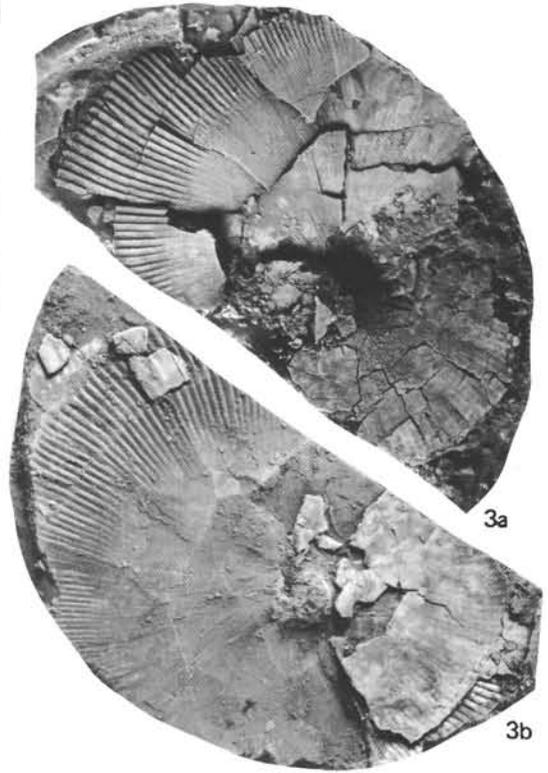
2a



1b



2b

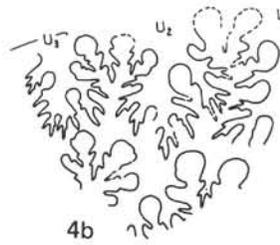


3a

3b



4a



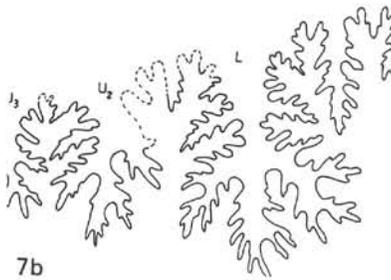
4b



5



6a



7b



7a

PLATE 2

- Figure 1a Sample 88-6, 41 to 42 cm. *Parasilesites kilianiformis* (Fallot), J 28244. Ribs between the constrictions are exposed clearly. Middle Albian. 1.5 ×.
- Figure 1b Impression showing fine ribs between constrictions. 1.5 ×.
- Figure 2a Sample 99-1, 54 to 55 cm. *Beudanticeras newtoni* Casey, J 28245. Compare Casey, 1961, pl. 29, fig. 2. Middle Albian. 1.5 ×.
- Figure 2b Fragment of suture at a whorl height of 14 mm. 5 ×.
- Figure 3 Sample 84-1, 68 to 70 cm. *Beudanticeras* sp., J 28246. Body chamber of a large specimen. Middle Albian. 1.5 ×.
- Figure 4a Sample 95-4, 99 to 100 cm. *Hypacanthoplites milleti-anus* (d'Orbigny), J 28247. Inner whorl, and fragment of adult whorl placed obliquely over the inner whorl. Lower Albian. 1.5 ×.
- Figure 4b Flattened venter, and angular shoulder of the adult whorl are visible. 1.5 ×
- Figure 4c Adult whorl section, partly reconstructed. 2 ×.
- Figure 5a Sample 88-5, 12 to 15 cm. *Lyelliceras lyelli* (d'Orbigny), J 28248. Cast. Middle Albian. 1.5 ×.
- Figure 5b Impression originally filled by pyrite crystals. 1.5 ×.
- Figure 6a Sample 95-5, 77 to 78 cm. *Hamites (Hamites) attenuatus* J. Sowerby, J 28250. Lower Albian. 1.5 ×.
- Figure 6b Fragmentary suture line.
- Figure 7a Sample 93-1, 104 cm. *Ptychoceras* cf. *laeve* Matheron, J 28249. Test fragments and suture. Lower Albian. 3 ×.
- Figure 7b Impression without traces of sculpture. 3 ×.
- Figure 7c Fragments of suture lines. 5 ×.
- Figure 8 Sample 105-3, 84 cm. *Lamellaptychus* sp., J 28220. Not determined, growth lines clearly visible. Probably Aptian. 3 ×.
- Figure 9 Sample 136-3, 92 to 94 cm. *Lamellaptychus angulocostatus* (Peters), J 28251. Hauterivian. 3 ×.

PLATE 2



1a



1b



2a



3



4a



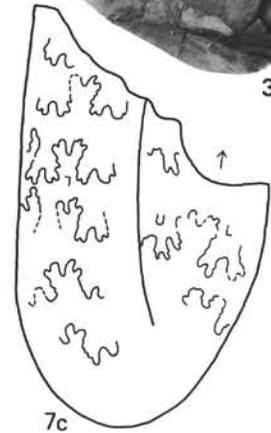
4b



2b



4c



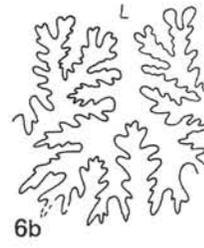
7c



5a



5b



6b



6



7a



7b



8



9