Introduction

Early Cretaceous benthic foraminifers were recovered from shallow-water limestone drilled in the western Mid-Pacific Mountains (MPM) at Allison Guyot (Site 865) and Resolution Guyot (Sites 866 and 867/868) during Leg 143 (Fig. 1). The MPM comprise several broad plateaus surmounted by flat-topped seamounts or “guyots” of known Cretaceous age (Hamilton, 1956; Heezen et al., 1973; Matthews et al., 1974). Drilling during Leg 143 was conducted to determine the history of Cretaceous volcanism and subsequent carbonate platform development for guyots in the western central Pacific Ocean. Accordingly, Resolution Guyot, a multiple-reef site, was drilled to extend through the carbonate cap and into the volcanic pedestal, whereas Allison Guyot, a single-bit site, was drilled into the cap.

Site 865 is located on the summit of Allison Guyot in the central MPM at 18°26.41’N, 179°33.34’W and a water depth of 1518.4 mbsf. About 731 m of Lower Cretaceous shallow-water limestone was drilled before basalt sills were encountered in the lowest 33 m of Hole 865A. The remaining three sites were drilled on Resolution Guyot in the western MPM as part of a transect across the perimeter of a MPM guyot. Site 866 was located on the northern rim of the summit about 1.5 km inward from the perimeter mound at 21°19.95’N, 174°18.84’E at a water depth of 1361.8 mbsf so as to penetrate lagoonal facies.

About 1600 m of Lower Cretaceous shallow-water limestone resting on basalt was drilled in Hole 866A; drilling extended 124 m farther into the basalt. Sites 867 and 868, located about 2 km northward of Site 866 and only about 400 m apart, were positioned for drilling into the summit of the perimeter mound (Site 867) and a lower terrace outside the mound (Site 868). Site 867, drilled at 21°20.96’N, 174°18.58’E at a water depth of 1352 mbsl, penetrated about 77 m of Lower Cretaceous shallow-water limestone. At Site 868, located at 21°21.17’N, 174°18.56’E and a water depth of 1385 mbsl, only about 17 m of Lower Cretaceous shallow-water limestone was penetrated.

Most of the biostratigraphy of the Lower Cretaceous shallow-water carbonates recovered from Leg 143 is based on benthic foraminifers owing to the near absence of planktonic foraminifers, calcareous nannofossils, and palynomorphs. Rudist bivalves represent an important biostratigraphic component of the biologic assemblage from Leg 143, but their occurrence is surprisingly rare and patchy at Allison and Resolution guyots and consists mostly of fragmental debris (see Massé and Swinburn, this volume). Accordingly, we present here the distribution and taxonomy of the biostratigraphically important Early Cretaceous benthic foraminifers and fecal pellets recovered, discuss the interpretation of their ages, and draw comparisons among these species, many of which are new or are previously undescribed from the Pacific Basin, and comparable species from well-known assemblages elsewhere. Our study focuses on Sites 865 and 866, the latter representing the oldest and most complete record from Leg 143 and, indeed, the oldest shallow-water carbonates yet recovered from the Pacific Basin. The stratigraphic distribution of benthic foraminifers and fecal pellets in Holes 865A and 866A is shown in Tables 1 and 2; most species are illustrated in Plates 1 through 5.

32. Early Cretaceous Shallow-Water Benthic Foraminifers and Fecal Pellets from Leg 143 Compared with Coeval Faunas from the Pacific Basin, Central America, and the Tethys

Annie Arnaud-Vanneau and William V. Sliter

Abstract

Early Cretaceous shallow-water benthic foraminifers and fecal pellets were recovered from Allison and Resolution guyots in the western Mid-Pacific Mountains (MPM) during Ocean Drilling Program Leg 143. These faunas are used to date the carbonate platform owing to the near absence of other microfossils. Four sites contained the Early Cretaceous assemblages: Site 865 on Allison Guyot, and Sites 866, 867, and 868, which were drilled as part of a transect across the perimeter of Resolution Guyot.

Of these sites, Site 866, located about 1.5 km inward from the perimeter mound on Resolution Guyot, provided the most complete record of carbonate sedimentation because drilling penetrated about 1600 m of Hauterivian to late Albian shallow-water carbonate rocks capped by a thin veneer of Maastrichtian to Pliocene pelagic sediments before encountering basalt. The Hauterivian age of the basal limestone pre-dates the clastic limestone of Barremian age from Deep Sea Drilling Project Site 463 in the MPM and thus represents the oldest shallow-water carbonate rocks yet recovered from the Pacific Basin.

Forty-four species of benthic foraminifers, including the new species Nezussata isabellae and Vercorussella wintereri, and three species of fecal pellets are grouped into five biostratigraphically significant assemblages: Assemblage I = late Albian, Assemblage II = middle(?) to late Aptian(?), Assemblage III = late Aptian(?) to early Albian(?), Assemblage IV = Barremian to early Aptian, and Assemblage V = Hauterivian. This biostratigraphic succession served as the standard for dating and comparing the Aptian(?) to-Albian sequence at Site 865 and the Albian sediments at Sites 867/868, as well as the Aptian-to-Albian shallow-water sequences drilled during Leg 144.

Although sparse, the Hauterivian to Aptian assemblages represent a mixture of species known from the northern and southern margins of the Tethys. Further, the stratigraphic succession of the Pacific species is the same as that in Tethyan sequences. Late Aptian to Albian assemblages are distinguished by an influx of species from Mexico and Venezuela associated with a Tethyan fauna.

Based on the benthic faunas, three major paleoenvironments corresponding to the development of the platform are recognized at Site 866: (1) sandy, normal-marine conditions in the Hauterivian, (2) restricted lagoonal conditions with stromatolites during the late Aptian, and (3) muddy facies with sponges and normal-marine lagoonal conditions during the late Aptian and Albian.
The stratigraphic distribution of benthic foraminifers and fecal pellets from Leg 143 was examined in thin sections cut perpendicular to bedding where possible. In addition, specimens were isolated from limestone using a complex technique that involves impregnating specimens with sodium sulfate in a vacuum bell jar and successively freezing and heating the limestone in a thermostating chamber. Freed specimens were examined in oriented thin sections, such as at the bases of graded beds, and in volcanioclastic breccias, fine conglomerates, and coarse sands.

The stratigraphic distribution of benthic foraminifers and fecal pellets in Tables 1 and 2 is shown according to the following scale for standard thin sections (about 20 × 30 cm):

- **VA** = very abundant (>10 specimens for large foraminifers and >20 for small foraminifers),
- **A** = abundant (6–10 specimens for large foraminifers and 10–20 for small foraminifers),
- **C** = common (3–5 specimens for large foraminifers and 3–10 for small foraminifers),
- **F** = few (2 specimens for both large and small foraminifers), and
- **R** = rare (single specimens for both large and small foraminifers).

Figures 2 and 3 display the distribution of key species after the examination of more than 600 thin sections from the Leg 143 collection of ODP and those of the participating scientists.

Sample notation follows the standard ODP format, given as drilling leg followed by site, core, core type (R = rotary), section, and interval (centimeters below top of section). The abbreviation “CC” refers to a core-catcher sample taken from the bottom of the cored interval.

**BIOSSTRATIGRAPHY**

The biostratigraphy used to date the succession of Early Cretaceous benthic foraminifers from Leg 143 is based primarily on the results of the Working Group on Benthic Foraminifera, IGCP Project No. 262, "Tethyan Cretaceous Correlation," chaired by A. Arnaud-Vanneau, and on previous European publications (e.g., Schroeder and Neumann, 1985). A stratigraphic distribution chart that summarizes the results of Project 262 was prepared by about 40 specialists from 14 countries. This collaboration clarified the stratigraphic distribution of the most important age-diagnostic benthic foraminifers from a broad geographic area, which includes the northern margin of the Tethys from the Crimea to Mexico; the Adriatic area from Greece, Albania, Croatia, Slovenia, and Italy; and the southern margin of the Tethys from the Middle East to Morocco. The distribution chart will soon be published in the final report of Project 262. Substage age correlations of the benthic succession in carbonate platform deposits are based, when possible, on ammonites in the Lower Cretaceous sequence (e.g., Hoedemaker et al., 1993) and pelagic foraminifers in the Upper Cretaceous sequence that were introduced during marine intercalations.

**Age-diagnostic Faunal Assemblages**

We distinguish five microfaunal assemblages that enable us to date the Hauterivian to Albian sequence of shallow-water carbonate rocks from Hole 866A (Fig. 2). This biostratigraphic succession provides the standard with which we date the younger assemblages from Hole 865A (Fig. 3).

**Assemblage I: Nezzazata sp. A, Nezzazata isabellea n. sp., Cuneolina parva, C. sp. cf. C. pavonia, Pseudonummoloculina sp. X, Trocholina sp. cf. T. lentularis, T. sp. cf. T. odakpaniensis, and Barberina sp. cf. B. barberensis** (see Tables 1 and 2; systematic descriptions below).

**Stratigraphic distribution:** From Samples 143-866A-3R-CC to -1SR-CC and from Samples 143-865A-17X-CC to -44R-CC.

**Age:** Large cuneolinids such as Cuneolina parva and Cuneolina pavonia range from the late Albian to Cenomanian, according to the authors who participated in the IGCP Working Group on Benthic Foraminifera. In addition, Cuneolina sp. cf. C. pavonia ranges from the uppermost middle Albian to the lower Cenomanian in Mexico, as shown in Figure 4. The range of Trocholina lentularis is from the upper Albian to the lower Cenomanian(%) in the Middle East (Henson, 1947). Only Barberina barberensis typically is restricted to the middle Albian, but the specimens from Hole 865A are too sparse and poorly sectioned to confirm the identification. Thus, in the absence of older age indicators, we suggest that this assemblage belongs to the late Albian.

**Assemblage II: Nezzazata isabellea n. sp., Cuneolina sp. A, orbitolinid B, Paracostolina sp. cf. P. sunnilandensis, Neoritrigia (?) sp., Arenobulimina sp. cf. A. chapmanii, Vercorsella sp. cf. V. arenata, V. sp. cf. V. scarcellai, Voloshinoides sp. A, Pseudonummoloculina sp., and a few, uncertain specimens of Cuneolina parva and C. sp. cf. C. pavonia.**

**Stratigraphic distribution:** From Samples 143-866A-15-CC to -57R-1 and from Samples 143-865A-4R-CC to -86R-1.

**Age:** The lower part of this assemblage is characterized by the occurrence of orbitolinids, Paracostolina sunnilandensis reported from the Albian of Texas, Mexico, and Venezuela (Mayne, 1955). The genus Neoritrigia is typical of the upper Albian in Europe, but very small forms are reported in the Albian (middle(?)) of Spain (E. Caus, pers. comm., 1993). This assemblage is considered to be of middle(?)/late(?)/Albian age.

**Assemblage III: Vercorsella sp. cf. V. immatura, Nezzazata isabellea n. sp., N. sp. B, Arenobulimina sp. A, and Buccirenata hedbergii.**

**Stratigraphic distribution:** From Samples 143-866A-5R-CC to -57R-82R-1 and from Samples 143-865A-8R-1 to -91R-3.

**Age:** Nezzazata sp. B and Arenobulimina sp. A are found in the upper Albian of the Aquitaine Basin (N'Da, 1984) and in upper Albian to lowermost Albian sediments of Mexico (Ortuno Arzate et al., 1989; Scott and Gonzalez-Leon, 1991; and Fig. 4). Buccirenata hedbergii has been described from the Albian to Albian of Venezuela by Mayne (1953). We suggest that this assemblage indicates a late Albian(%) to early Albian(?)/age.

**Assemblage IV: Protopeneroplis sp., Nezzazata(?) sp. C, Falsurgonina(?) sp., and Neotrocholina sp. cf. N. friburgensis.**

**Stratigraphic distribution:** From Samples 143-866A-2R-1 to -12R-6.
<table>
<thead>
<tr>
<th>Table 1</th>
<th>Stratigraphic distribution of Early Cretaceous benthic foraminifers and fecal pellets from Hole 866A.</th>
</tr>
</thead>
<tbody>
<tr>
<td>Age</td>
<td>Decamorella n. sp.</td>
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<td>Valvulineria (?) sp. 1</td>
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<td>Verconella winteri n. sp.</td>
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<td>Belouvieille sp.</td>
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<td>Areobulimina sp.</td>
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<td>Protopeneroplis sp.</td>
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<td>Neotrocholina sp.</td>
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<td></td>
<td>Verconella sp.</td>
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<td>Trocholina molesta</td>
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<td>Campanellina capitensis</td>
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<td></td>
<td>Favreina cf. praenesis</td>
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<td>Debarina cf. nashicamenensis</td>
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<td>Orbitolinid (?)</td>
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<td>Novalesia producta</td>
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<td></td>
<td>Verconella cf. areata</td>
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<td></td>
<td>Verconella cf. immaturata</td>
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<td></td>
<td>Neotrocholina cf. infragranulata</td>
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<td>Neotrocholina cf. librogenata</td>
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<td></td>
<td>Aeoliscus koi                                    <strong>Note:</strong> It seems there might be an error in the data entry. Please verify the table for accuracy.</td>
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<td>Bdelloidina cf. urgenensis</td>
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<td>Novalesia angusti                                <strong>Note:</strong> It seems there might be an error in the data entry. Please verify the table for accuracy.</td>
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<tr>
<td></td>
<td>Cuneolina sp. A</td>
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<td>Praecriotsalina infraclavacea</td>
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<td>Nezzazata lebe n. sp.</td>
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<td>Pseudorummosculitae sp.</td>
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<td>Cuneolina parva</td>
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<td>Orbitolinid A</td>
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<td></td>
<td>Paracorneolina cf. surrillanderesi</td>
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<td>Sabaudia minuta</td>
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<td>Hagenowinea sp.</td>
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<td>Pataxius salinensis</td>
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<td>Verconella cf. scarcella</td>
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<td>Neoana (?) sp.</td>
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<td>Cuneolina cf. pavonia</td>
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<td>Nummoloculina (?) sp.</td>
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<td>Nezzazata sp. A</td>
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Table 2. Stratigraphic distribution of Early Cretaceous benthic foraminifers from Hole 865A.

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540
Figure 2. Distribution of the most important Early Cretaceous benthic foraminifers from Hole 866A. Foraminiferal illustration shows occurrence.
**Figure 3.** Distribution of the most important Early Cretaceous benthic foraminifers from Hole 865A.

**Age:** *Protopeneroplis* sp. and *Falsurgonina(?)* sp. are found only in the lower part of this interval. The genus *Protopeneroplis* is typical of the Berriasian to Valanginian interval and generally is thought not to occur younger than the Hauterivian (Bucur, 1993). However, it may occur in the Barremian of Italy (M. Chiocchini, pers. comm., 1992). The genus *Falsurgonina* ranges from the Hauterivian(?) to the lower Aptian in France (Arnaud-Vanneau, 1980), whereas *Neotrocholina friburgensis* typically ranges from the latest Barremian to the earliest Aptian (Arnaud-Vanneau, 1980). This faunal assemblage thus suggests a Barremian to early Aptian age.

**Assemblage V:** *Campanellula capuensis*, *Melathrokerion* sp. cf. *M. valserinensis*, *Valvulineria(?)* sp. 1, *Decussocolulina* sp. cf. *D. mirceai*, *Vercorsella wintereri* n. sp., and *Favreina* sp. cf. *F. prusensis*.

**Stratigraphic distribution:** From Samples 143-866A-129R-6 to -171R-1.
Figure 4. Distribution of Albian benthic foraminifers from two sections in the Chihuahua Basin, Mexico (modified from Ortuno Arzate et al., 1989): Cuchillo Parado (shown in white) and Sierra Boquilla (shown in gray). The lithology shown is from the Cuchillo Parado section.
Age: This assemblage is characterized by the presence of *Ver- 
corella winterieri* n. sp. and *Valvulinispira* (?) sp. 1. Within the primary 
assemblage, we distinguish two secondary assemblages. The lower 
secondary assemblage (from Samples 143-886A-129R-6 to -167R-2) contains specimens provisionally referred to *Decussocololina mir- 
recai* that originally was described from the Berriasian to Valanginian 
by Neagu (1984). The upper secondary assemblage (from Site 315 in the Line 
Islands by Premoli Silva and Brusa (1981).

In summary, the benthic foraminifers and fecal pellets from Leg 143 date the carbonate platform in the PPM as Early Cretaceous 
(Hauterivian to Albian) in age. Only Site 866 on Resolution Guyot has a thick carbonate section resting on basalt where the age of the 
oldest carbonate deposits is Hauterivian. At the other sites, the age of the 
oldest carbonate sedimentary rocks recovered is younger and probably Albian at Sites 867/868 and possibly late Aptian at the bottom 
of Hole 865A, where the limestone is intruded by one or more basalt sills. In contrast, the youngest shallow-water carbonate rocks 
at all sites are represented by faunas of assemblage I, which suggests that the demise of platform sedimentation was more or less coeval 
during the late Albian (see Sliter, this volume).

PREVIOUS RECORD FROM THE PACIFIC OCEAN 
BASIN

The Cretaceous age of many seamounts and guyots in the northwest 
Pacific, which stretch from the Japanese group through the Marzu- 
Wake chain to the PPM, was established since the 1950s largely 
through dredge hauls (e.g., Hamilton, 1956; Tsuchi and Kagami, 1957; 
Matthews et al., 1974; Ladd et al., 1974) and later through drilling (e.g., 
Winterer et al., 1973; Heezen et al., 1973; Thiede et al., 1981). Paleon-
tologic ages from the dredges, based primarily on macrofaunal debris, 
generated a general Barremian to Albian age for the shallow-water carbonate 
rocks. Results from drilling provided age control based on 
microfossils for the overlying pelagic carbonate materials. Within this 
record, information regarding Early Cretaceous benthic foraminifers 
was mostly limited to rare specimens from the Cuneolinidae (*Cuneo-
olina*, *Barkerina*, *Sabaudia*), the Orbitolinidae (*Conicorbitolina*, 
*Neozia*, *Orbitalina*), and *Trocholina*. Identifications often were 
limited to genera and precise descriptions are lacking.

Drudges from Daiichi Kashima Seamount recovered benthic for-
aminifers dated as Early to middle Cretaceous (Research Group for 
Specimens attributed to *Orbitalina lenticularis* (Blumenbach) 
by Shiba (1988) probably are *Conicorbitolina* sp., and the forms referred to *Cuneolina laurentii* are probably *Cuneolina parva*.

Fragments of *“Orbitalina”* were dredged from Isakov Guyot 
(Heezen et al., 1973) and found reworked in upper Oligocene sedi-
ments from Site 462 in the Nauru Basin (Premoli Silva and Brusa, 
1981). Reworked specimens of *Cuneolina* are reported from Cenoma-
onian strata at Site 711 on Horizon Guyot and from Campanian sedi-
ments at Site 315 in the Line Islands by Premoli Silva and Brusa (1981).

Recent dredging from Lo-En Guyot in the Marshall Islands 
recovered forms attributed to *Sabaudia* associated with the planktonic 
foraminifer *Favusella washingtonensis* (Lincoln et al., 1993). Recent 
reports by Schlager and Philip (1990), Gröttsch (1991), Gröttsch 
and Flügel (1992), and Gröttsch et al. (1993) on dredged material from 
Charlie Johnson, Isakov, MIT, Woods Hole, and Allison guyots indi-

### COMPARISON WITH OTHER AREAS

#### Central America

Early Cretaceous benthic foraminifers are well known and 
described in detail from the eastern margin of the Pacific Ocean and the Caribbean (e.g., the Aptian to Albian of Mexico and Venezuela). For 
comparison, we have selected two Albian to lower Cenomanian sec-

tions from the Chihuahua Basin of Mexico at Cuchillo Parado and Sierra Boquilla (Fig. 4) that previously were studied by Ortuno Arzate 
et al. (1989).

In the Chihuahua Basin, the carbonate platform deposits are 
repre-
sented by a 7000-m-thick unit that extends from the middle lower 
Albian to the lower Cenomanian. We have no data concerning Aptian 
sediments in this region. The stratigraphic distribution of benthic 
foraminifers, such as *Orbitolina* (*Mesorbitolina*) *texana*, and *Bar-
kerina Barkerensis*, are similar in the Chihuahua Basin and in the 
Lam-

Assemblage II at Site 866 on Resolution Guyot. Other species in this 
association, however, such as *Cuneolina* sp. cf. *Melathrokerion 
D. mirceai* sp. cf. *Decussolo-

Assemblage I and suggest that the same assemblage exists at MIT Guyot, if not 
throughout the northwest Pacific Ocean. The association of these 
sp. cf. *M. valserinensis* sp. cf. *Melathrokerion* *D. mirceai* is found only at the bottom of the primary 
assemblage and *Campanellula capensis* only at the top may indicate 
that the Hau-
terivian section is complete or nearly so.

In summary, the benthic foraminifers and fecal pellets from Leg 143 date the carbonate platform in the PPM as Early Cretaceous 
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foraminifer *Favusella washingtonensis* (Lincoln et al., 1993). Recent 
reports by Schlager and Philip (1990), Gröttsch (1991), Gröttsch 
and Flügel (1992), and Gröttsch et al. (1993) on dredged material from 
Charlie Johnson, Isakov, MIT, Woods Hole, and Allison guyots indi-

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EARLY CRETACEOUS BENTHIC FORAMINIFERS

Figure 5. Distribution of Early Cretaceous benthic foraminifers from the Fara Martino section (A) of central Italy (after Arnaud-Vanneau and Arnaud, 1988), originally located on the southern margin of the Tethys, compared to the distribution at Site 866 (B).

**Tethys**

For a comparative Hauterivian to Aptian section from the Tethys, we have selected the Fara San Marino section in central Italy, studied by Arnaud-Vanneau and Arnaud (1988), that is similar to Site 866 in depositional facies and species content (Fig. 5). At Fara San Marino, the Hauterivian to lower Aptian carbonate platform sequence is 300 m thick and was originally located on the southern margin of the Tethys. Facies are mostly restricted marine and display algal-microbial layers and numerous stromatolites. In Italy, the restricted facies extend south to Gargano, where the same stratigraphic interval is referred to as the "membre loféritique" by Luperto Sinni and Masse (1986) owing to the numerous stromatolites.

The Pacific sediments from Site 866 also indicate the development of stromatolites and algal-microbial layers during this time interval. More importantly, the stratigraphic distribution of key species is similar between the Italian and Pacific sites. Further, the Pacific biostratigraphic interpretations are in general accord with the strontium-isotope stratigraphy of Jenkyns et al. (this volume). The stratigraphic position of *Campanelulta capuensis* is constrained to the uppermost Hauterivian in Italy (Chiocchini and Mancinelli, 1977; Luperto Sinni and Masse, 1986), and the distribution apparently is similar at Site 866. *Valvulineria* (?) sp. 1 ranges from the Hauterivian to the lower Aptian in the two sections. *Praechrysalidina infractetacea* ranges from the Aptian to the Albian. *Aeolisaccus katori*, confined to the southern margin of the Tethys, also ranges from the Aptian to the Albian but was identified only in the Albian at Resolution Guyot.
Three other species characterize the Hauterivian to lower Aptian interval at Site 866: 

- *Falsurgonia* sp., specimens referred to *Neotrocholina* sp. cf. *N. fribergensis*, and *Decussoloculina* sp. cf. *D. mirceai*. These species are not shown in Figure 5 as the type specimens are restricted to the northern margin of the Tethys. *Falsurgonia* ranges from the Hauterivian to the Barremian and *Neotrocholina* is known from the lower Aptian. *Decussoloculina* sp. cf. *D. mirceai* from the Pacific is similar in morphology to the type species described from Romania.

In summary, benthic foraminifers from the Hauterivian to Aptian interval in the Pacific display the same evolutionary succession as do those from the carbonate platform on the southern margin of the Tethys in Italy. The stratigraphic distribution of species is the same, with the addition of species from the northern Tethys during the Barremian and early Aptian.

### Biogeographic Conclusions

All the Early Cretaceous benthic foraminifers identified from Allison and Resolution guyots are known from the margins of the Tethys, except for the new species *Vercorsella wintereri* n. sp., *Cuneolina* sp. A, and a presumed new orbitolinid genus and species. The minute size of both *Vercorsella wintereri* n. sp. and *Cuneolina* sp. A may explain their apparent absence in earlier studies, and the identification of the new orbitolinid requires oriented thin sections across the embryonic apparatus of isolated specimens to confirm its identification. For these reasons, we are not sure that true endemic shallow-water species existed in the Early Cretaceous Pacific Ocean.

The Hauterivian to Aptian benthic foraminifer assemblages from Leg 143 contain a mixture of species known from the northern and southern margins of the Tethys, as shown in Figure 6. The Hauterivian sediments of the Pacific atolls are characterized by the diagnostic species *Companellula capensis*, which is restricted to the southern margin of the Tethys. However, we also identified specimens resembling *Decussoloculina mirceai*, which is a species described from the northern margin of the Tethys.

The Barremian to lower Aptian sequence displays a mixed fauna having restricted northern taxa, such as *Falsurgonia*, and specimens tentatively assigned to *Neotrocholina fribergensis*, which occur together with restricted southern species such as *Prachyrislidina cretacea* and *Aeolisaccus kotori*.

The upper Aptian to Albian sequence includes typical American faunas that were introduced for the first time following the opening of the central Atlantic Ocean. These faunas include: (1) southern margin species such as *Prachyrislidina infracretacea* and forms resembling *Trocholina lenticularis* (known from the Middle East); (2) the northern-margin taxa *Iraqia* (rare); and (3) species from Central America such as *Paracostominella sumilandesis*, and specimens tentatively referred to *Barkerina bakkerensis* and *Cuneolina pavonia*, the latter specimens resembling the form referred to as *C. walteri* by Scott and Gonzalez-Leon (1991). Furthermore, *Barkerina bakkerensis* and *Cuneolina pavonia* are also known from Europe.

The degree of mixing of benthic species known from the two margins of the Tethys in the faunas from the central Pacific Ocean is unusual and important to biogeographic considerations. Similar faunal mixing is known in regions from the southern margin of the Tethys located in the Adriatic area (Slovenia, Croatia) that paleogeographically were close to the northern margin of the Tethys during the Early Cretaceous (Fig. 6). Other than these examples, however, no other such biogeographically mixed Early Cretaceous benthic faunas are known.

### DEPOSITIONAL ENVIRONMENTS

In the following discussion, we consider the benthic foraminifers together with other biogenic and lithogenic constituents in the samples collected to determine the succession of environments that occurred during the depositional history of the carbonate platforms. The positions of the sites on Resolution and Allison guyots relative to the margin of the platform are important for explaining the types of environments that are represented on each guyot. However, the most important factor is the age of the sediments and the types of species that existed at that time. We begin our discussion with the thick sequence at Site 866 and then consider the sequence at Site 865. The distribution of biogenic constituents at each site is shown in Tables 3 and 4.

### Site 866 (Resolution Guyot)

Two major environments are represented in the Hauterivian section at Site 866. From Samples 143-866A-171R-1, 21–24 cm, to -154R-1, 51–52 cm, environments with normal salinity and normal oxygenation are suggested by the presence of a few nodosariids, *Marsonella* and bryozoans (Table 3). The interval is represented by oolitic and/or oncolithic sand and the sparse microfauna includes small bivalve benthic foraminifers such as *Vercorsella wintereri* n. sp. (common), *Valvulinera* (rare to few), and *Belorussiella* (rare to few). Miliolids are missing.

During deposition of Samples 143-866A-153R-1, 116–118 cm, to -132R-1, 55–58 cm, environments were muddy and the microfauna includes *Istriloculina* and ostracodes with more restricted-marine intervals represented by evidence of algal-microbial activity. The presence of miliolids, textularids, *Vercorsella wintereri* n. sp., and *Valvulinera* sp. 1 indicate that lagoonal conditions existed between periods of restricted-marine conditions.

Environments during the Barremian to lower Aptian interval, from Samples 143-866A-131R-1, 92–94 cm, to -88R-1, 77–79 cm, were mostly dominated by strong algal-microbial activity and the development of stromatolites. Except for ostracodes and *Istriloculina*, the microfauna is rare. The widespread algal-microbial activity that characterized this period is of special interest. In today’s oceans, it is difficult to imagine such restricted-marine environments with below-normal salinity and oxygen values so close to the margin of a relatively small Pacific island.

During the late Aptian to early Albian, conditions became increasingly closer to normal marine. Three types of environments are distinguished. From Samples 143-866A-87R-1, 77–79 cm, to -79R-1, 77–79 cm, the presence of *Marsonella* and *Belorussiella* identify normal-marine conditions. From Samples 143-866A-77R-1, 91–93 cm, to -79R-1, 88–89 cm, the environment approached reefal conditions. Fragments of corals, echinoids, calcareous sponges, *Polystrata alba*, and large dasyyclads are present, and, as is usual in this kind of environment, the foraminiferal fauna is sparse and only specimens of *Vercorsella* sp. cf. *V. immatura* are common. Still, the environment is not truly reefal material is rare. Finally, in the uppermost part of this interval, from Samples 143-866A-71R-1, 64–67 cm, to -58R-1, 21–23 cm, restricted-marine environments reappear including evidence of algal-microbial activity and stromatolites.

During the middle to late Albian, restricted-marine environments disappeared and facies were mostly muddy with abundant, large sponge spicules. From Samples 143-866A-58R-CC, 21–23 cm, to -2R-2, 7–8 cm, normal-lagoon environments are present with an upward increase in *Cuneolina*, *Vercorsella*, and miliolids which are present throughout and are sometimes abundant. *Neozuccata* also is present and the microfauna is increasingly diverse, with up to 20 species identified.

### Site 865 (Allison Guyot)

More than 700 m of upper Aptian to Albian shallow-water carbonate rocks was recovered at Site 865. The facies mostly are lagoonal, muddy, and rich in large sponge spicules (Table 4). A relationship exists between the density of sponge spicules and the abundance of benthic foraminifers. When spicules are abundant, foraminifers are rare and vice versa.
Three types of depositional environments are identified. From Samples 143-865A-94R-3, 123–124 cm, to -91R-3, 89–93 cm, the environment represents the first deposition of carbonate materials on the guyot during a transgression. The microfacies contains a mixture of volcanic debris, clay, wood fragments, and worn small benthic foraminifers. In this assemblage, only large foraminifers such as *Bucicrenata hegbergi* with an agglutinated test and fragments of arthropods seem autochthonous. The environment probably was very shallow.

From Samples 143-865A-90R-1, 45–47 cm, to -84R-1, 53–60 cm, the sediment contains less clay, and small-sized benthic foraminifers are abundant, especially *Nezzazata isabellae* n. sp. Benthic foraminifers are diverse, with 13 species identified, whereas large sponge spicules are very few to common. Lagoonal environments and low-energy muddy facies are interpreted for sediments from Samples 143-865A-80R-1, 32–38 cm, to -44R-CC, 14–16 cm. The biofacies consists of abundant to very abundant sponge spicules and a low-diversity benthic foraminifer assemblage limited mostly to abundant miliolids and *Nezzazata isabellae* n. sp.

The interval from Samples 143-865A-43R-CC, 1–2 cm, to -17X-CC, 34–36 cm, contains normal-marine biofacies with increasingly abundant benthic foraminifers. As at Site 866, microfaunas are dominated by *Cuneolina, Vercorsella*, and miliolids with less abundant nezzazatids. The diversity increases upsection; however, only 18 species were identified at Site 865.

In summary, three major depositional environments were identified in the Lower Cretaceous shallow-water carbonate sequence from Leg 143. The first, which can be found in the Hauterivian at the base of the carbonate sequence at Site 866, corresponds to a sandy environment with normal-marine salinity and oxygen conditions. During this time, Resolution Guyot probably was an island that lacked a true lagoon and protected environments. The latter is suggested by the absence of a true muddy facies.

Noticeably restricted-lagoonal conditions occurred during the Barremian to early Aptian with the development of strong algal-microbial activity and stromatolites. Carbonate productivity of microbial origin quickly extended to sea level, and the sedimentation represents a type of "catch up" series (James and Macintyre, 1985). It is interesting to note a similar period of strong microbial activity during the Barremian to early Aptian in central Italy. At that time, the platform sequence in Italy was at a paleolatitude of about 15°N, whereas Resolution Guyot was 18°S. This, albeit limited, comparison perhaps identifies a paleolatitudinal core interval favorable to the development of microbial activity.

Late Aptian to Albian depositional environments were similar at Sites 866 and 865 and are characterized by muddy facies, large sponge spicules, and normal-marine lagoonal conditions. No evidence of restricted-marine conditions was found throughout the interval. Carbonate sedimentation was in a "keep up" mode, with the rate of production matching the rate of rise in sea level. During this time, the guyots were located near the paleoequator, and the benthic foraminifer faunas were relatively abundant and diversified.

**CONCLUSIONS**

The results from Leg 143 provided important new information on the biogeography of Early Cretaceous benthic foraminifers and the history of carbonate platform sedimentation in the central Pacific Ocean, chief of which was the discovery of the oldest carbonate platform yet known from the Pacific, the Hauterivian at Resolution Guyot. Demise of the carbonate platform at both Allison and Resolution guyots, and perhaps elsewhere in the Pacific, took place more or less at the same time during the late Albian (Sliter, this volume).

Within the Hauterivian to Albian sequence at Site 866, five age-diagnostic faunal assemblages are identified:


Table 3. Ecologic distribution of Early Cretaceous biogenic material from Hole 866A.

<table>
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<th>Biodetritus</th>
<th>Core section interval (cm)</th>
<th>Ammonites</th>
<th>Bioclasts</th>
<th>Bryozoans</th>
<th>Brachiopods</th>
<th>Conulariids</th>
<th>Corals</th>
<th>Foraminifera</th>
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<th>Radiolaria</th>
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<th>Scaphitids</th>
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Environments: Normal marine, Restricted.
Table 4. Ecologic distribution of Early Cretaceous biogenic material from Hole 865A.
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550

sp. cf. V. arenata, V. sp. cf. V. scarsellai, and Voloshinoides sp. A. of middle(?) to late(?) Albian age.


The Leg 143 microfauna is neither abundant nor diverse. Minimum abundance was found in the Hauterivian sequence, the maximum in the Albian. The evolutionary succession of the microfauna is the same as that described for faunas from the Tethys by Arnaud-Vanneau (1986). During the Hauterivian, the microfauna is sparse and of low diversity. After the Barremian, the number of genera and species increases upsection to the Albian. Nevertheless, the Pacific faunas are the least diverse of the faunas studied. This may be attributed to the paleogeographic position near the paleoequator and/or to the geographic isolation in the vast Cretaceous Pacific Ocean. Still, 44 species of Early Cretaceous benthic foraminifers and three species of fecal pellets were identified and described.

The benthic foraminifer fauna from the Hauterivian to lower Aptian sequence at Site 866 is identical to that observed in the Tethys. There was no apparent barrier to migration of the benthic faunas throughout the tropical oceans. The appearance of typical American species in the upper Aptian to Albian sequence demonstrates that a certain isolation existed at that time between Europe and Africa on the one hand, and the Americas on the other. The Pacific region, however, was not affected by the isolation and continued to receive migrating microfaunas from all sources.

One aim of Leg 143 was to identify the oldest atoll and reef facies. Pacific forms are smaller and more compressed than the type specimens of Pacific forms. The Pacific region, however, was not affected by the isolation and continued to receive migrating microfaunas from all sources.

Three major types of depositional environments were identified that correspond to three steps of platform development. The first corresponds to the initial development of the platform during the Hauterivian. At that time, there probably was no lagoon and Resolution Goyet was a sandy island. The second step corresponds to the development of a true lagoon during the Barremian to early Aptian. The lagoon was restricted to normal-marine flow, contained stromatolites, and was filled with carbonate particles of microbial origin.

The final step during the late Aptian and Albian corresponds to the development of muddy lagoon environments with numerous sponges and a more or less normal salinity. Although the biofacies indicates increasingly normal-marine conditions, the presence of incipient calciturbation and desiccation cracks in the lithologic sequence provides continued, though diminishing, evidence of subaerial emergence (Sager, Wimmer, Firth, et al., 1953). The latest Albian samples at both Sites 865 and 866 consist of wackestone with the typical cuneolinid-miliolid assemblage that characterizes the sequence. Nothing in the biofacies adjacent to the upper contact of the shallow-water limestone foretells the future demise of the platform.

**SYSTEMATIC DESCRIPTIONS**

Here, we describe the biostratigraphically important Early Cretaceous benthic foraminifers and fecal pellets identified in our post-cruise analysis. Forty-four species of benthic foraminifers and three species of fecal pellets are described and illustrated to provide a solid taxonomic basis for future studies in the Pacific Basin (see Figs. 1 through 5; Appendix). The synonymic list is reduced to the original description of each species followed by the principal revisions, and previous references in the Pacific area. For the most part, we have followed the taxonomic classification of Loeblich and Tappan (1988).

Many of the following species identifications are associated with the abbreviation "cf.". We use this abbreviation to indicate probable similarity. Although the scarcity of specimens, poor preservation, and nondiagnostic thin sections often prevent exact identification, we fully expect that identity would be established if adequate material were available for study. Thus, although we treat the identifications as complete in reference to stratigraphic and geographic distribution, we apply a conservative nomenclature pending further study of this first, and important, discovery from the Pacific Ocean.

Order FORAMINIFERIDA Eichwald, 1830

Family HAPLOPHRAGMOIDIDAE Mayne, 1952

Genus DEBARINA Bourcad, Raoult and Vila, 1972

Debarina sp. cf. D. haouenerensis Fourcade, Raoult, and Vila, 1972

(Pl. 1, Figs. 1-2)

**Description.** Test planispiral, partially involute, slightly compressed. Protoconch small, globular, followed by three or four whorls of subrectangular chambers in axial section, with up to 12 chambers per whorl. Wall of coiling in initial whorl is more or less perpendicular to the plane of subsequent whorls (Pl. 1, Fig. 2). Wall calcareous, microgranular. Aperture a row of rounded pores at base of apertural face.

**Remarks.** About 20 specimens were observed in thin section. These Pacific forms are smaller and more compressed than the type specimens of Debarina haouenerensis.

Age and occurrence. Late Aptian to Albian, from Sections 143-865A-82R-2 to -57R-1 and 143-866A-66R-1 to -6R-CC.

Known range. Late Barremian to Albian.

**Geographic distribution.** Originally described from the Aptian of Algeria, this species is widespread along the margins of the Tethys.

Family CHARENTIIDAE Neumann, 1965

Genus MELATHROKERION Brünnimann and Conrad, 1967

Melathrokerion sp. cf. M. valserinensis Brünnimann and Conrad, 1967

(Pl. 1, Figs. 3-4)

**Description.** Test planispiral, involute, protocoonch globular, followed by two or three whorls of globular chambers. Wall agglutinated, microgranular, thick, with septa that thin rapidly from the wall to the aperture (Pl. 1, Fig. 3), later striated by narrow canaliculi. Aperture large, areal, euriplancetic.

**Remarks.** About 10 specimens were observed in thin section. The Pacific specimens are smaller and more compressed than the type specimens, but similar forms are known from the Hauterivian of Slovenia.

Age and occurrence. Probable Hauterivian, from Samples 143-866A-154R-1, 110-112 cm; -153R-2, 20-22 cm; -152R-1, 4-5 cm; and -149R-1, 91-93 cm.

**Known range.** Barremian to early Aptian.

**Geographic distribution.** This species is known from the northern margin of the Tethys in Spain, France, and Switzerland and was originally described from the Barremian to lower Aptian of the French Alps.

Family CYCLAMMINIDAE Marie, 1941

Subfamily BUCCIICRENAVITAE Loeblich and Tappan, 1985

Genus BUCCICRENATA Loeblich and Tappan, 1949

Buccicrenata hedbergi (Mayne)

(Pl. 1, Fig. 5)

**Description.** Test planispiral, involute, slightly compressed. Protoconch globular with four chambers in the spire. Chambers increase rapidly in size, separated by depressed sutures. Wall agglutinated of coarse calcareous particles, alveolar. Aperture an areal slit.

**Remarks.** Six specimens were observed in thin section.

Age and occurrence. Albian to late Aptian(?), from Samples 143-865A-89R-5, 1-4 cm, and -89R-4, 72-75 cm.

**Known range.** Berriasian to Albian.

**Geographic distribution.** This species was described from the Aptian to Albian of Venezuela and is widely known from the margins of the Tethys.

Family BARKERINIDAE Frizzell and Schwartz, 1950

Genus BARKERINA Frizzell and Schwartz, 1950

Barkerina sp. cf. B. Barkerensis Frizzell and Schwartz, 1950

(Pl. 1, Fig. 6)
**Description.** Test globular, planispiral, involute. Low and broad chamber subdivided by transverse partitions. Wall microgranular. Aperture a row of arched openings at the base of apertural face.

**Remarks.** Two specimens, observed in subaxial and tangential thin sections, resemble *Barkerina barkerensis*. Although transverse partitions are clearly visible in the tangential section (Pl. 1, Fig. 6), the specimens are too sparse and too poorly cut to confirm the identification.

**Age and occurrence.** Albain, from Sample 143-865A-24R-CC, 5–6 cm.

**Known range.** Albain (middle).

**Geographic distribution.** Originally described from the Albain of Texas, *Barkerina barkerensis* also found in Mexico and Venezuela.

Family **SPIROPLECTAMMINIDAE** Cushman, 1927

Subfamily **SPIROPLECTAMMININAE** Cushman, 1927

Genus **AMMOCALCIDOIDES** Plummer, 1932

Ammocalcidoides sp.

(Pl. 1, Fig. 7)

**Description.** Test small, elongate, slightly compressed (maximum height, 0.2 mm). Protoconch small, rounded, followed by 11 to 12 chambers in a planispiral coil, later biserial with three or four rows of chambers. Wall agglutinated. Aperture a slit at base of final chamber.

**Remarks.** Three specimens were observed in subaxial sections.

**Age and occurrence.** Probable Hauterivian, from Sample 143-866A-146R-1, 111–114 cm.

Subfamily **NOVALESIINAE** Loeblich and Tappan, 1984

Genus **NOVALESIA** Magniez, 1974

**Novalesia angulosa** (Magniez)

(Pl. 1, Figs. 9–11)

**Spirocolomminoides angulosa** nov. gen., nov. sp., Magniez, 1972, pp. 189–190, pl. 2, figs. 1–11a, pl. 5, figs. 1b–7, text-fig. 4.

**Description.** Test elongate (maximum height, 0.65 mm), triangular in axial section with an acute apical angle of about 15°. Early stage planispiral with a protoconch followed by a few chambers (Pl. 1, Fig. 9), later biserial with a maximum of eight rows of chambers. Chambers subdivided by thin radial beams (Pl. 1, Fig. 11). Wall agglutinated. Aperture a low interiomarginal slit.

**Remarks.** Six specimens were observed in axial and subaxial sections and are identical to the type specimens.

**Age and occurrence.** Albain, from Samples 143-865A-59R-CC, 4–6 cm; 46R-CC, 15–16 cm; 143-866A-47R-1, 70–72 cm, and 143-866B-8R-2, 20–21 cm.

**Known range.** Late Aptian (Gargasian) to Albain.

**Geographic distribution.** This species, described from the Albain of the Pyrenees, is known from France and Spain.

**Novalesia producta** (Magniez)

(Pl. 1, Fig. 8)

**Spirocolomminoides productus** nov. gen., nov. sp., Magniez, 1972, pp. 181, 185, 186, 189, pl. 1, figs. 1a–13b, pl. 4, figs. 1b, 2, 3, 4b, 5, 6b, 7b, 8–12.

**Description.** Test small, elongate (maximum height, 0.30 mm), triangular in axial section, early stage planispiral with a protoconch partly surrounded by four chambers, later biserial with a maximum of eight rows of chambers. Chambers subdivided by two to four thin radial beams. Wall agglutinated. Aperture a low interiomarginal slit.

**Remarks.** Fourteen specimens were observed in axial and subaxial sections. The Pacific specimens, although similar in morphology to the type specimens, are smaller and have fewer chambers.

**Age and occurrence.** Albain, from Samples 143-866A-156R-1, 81–85 cm; 155R-1, 119–122 cm; 154R-2, 119–121 cm; 153R-2, 20–22 cm; 152R-1, 4–5 cm; 150R-3, 66–69 cm; and 143-866B-8R-2, 20–21 cm.

**Known range.** Late Aptian to Hauterivian.

**Geographic distribution.** This species was originally described from the Albian of the Pyrenees and is widespread along the margins of the Tethys.

Family **VERNEUILINIDAE** Cushman, 1911

Subfamily **VERNEUILININAE** Cushman, 1927

Genus **AMMOBACULOIDES**

Ammobaculoides sp. (Reuss)

(Pl. 1, Figs. 19, 20)

**Bolivina textularioides** Reuss, 1863, pl. 10, fig. 1.

**Description.** Test small, conical, with a flat to slightly concave base, trochoid with four or more chambers per whorl, height 0.2 mm. Chambers triangular and densely packed in tangential section. Intracameral sutures depressed and form an acute angle to the axis of coiling. Wall agglutinated, of microgranular calcite. Aperture of pores at margin of septa.

**Remarks.** Specimens of *Campanellula capensis* in the present material are rare and limited to two thin sections: one tangential and one transverse oblique. These sections, however, are characteristic of the species, and the thickness and size of the test are identical to typical specimens from the southern margin of the Tethys.

**Age and occurrence.** Hauterivian, probably late Hauterivian, from Samples 143-866A-147R-1, 95–97 cm; and 143-866B-8R-2, 20–21 cm.

**Known range.** Late Hauterivian.

**Geographic distribution.** This species, described from the Hauterivian of Italy, previously was known only from the southern margin of the Tethys in Italy, Croatia, Slovenia, North Africa, and southern Spain.

Family **ATAXOPHRAGMIIDAE** Schwager, 1877

Subfamily **ATAXOPHRAGMIINAE** Schwager, 1877

Genus **ARENOBULIMINA** Cushman, 1927

Are nobulimina sp. cf. *A. chapmani* Cushman, 1936

(Pl. 1, Figs. 15, 16)

**Description.** Test small, conical, trochospiral, broad (maximum height, 0.45 mm, maximum diameter, 0.42 mm) with a wide umbilicus (Pl. 1, Figs. 15–18). Chambers inflated, increasing rapidly in size and number with up to five in the early stage and seven in the later stage, separated by depressed sutures. Wall agglutinated, thick, microgranular calcareous. Aperture at base of apertural face, obscured.

**Remarks.** About 35 specimens were observed in thin section. The Pacific specimens differ from typical *Are nobulimina chapmani* in being smaller and having an agglutinated calcareous test. *Are nobulimina chapmani* previously was identified from whole specimens; it is difficult, therefore, to compare the morphology to specimens in thin section. Nevertheless, the present specimens tentatively are attributed to *Are nobulimina chapmani* as the overall morphology, number of chambers in the final whorl, and umbilical characteristics are similar.

**Age and occurrence.** Albain, from Samples 143-865A-87R-2, 32–34 cm; -86R-1, 16–20 cm; -85R-2, 41–42 cm; -82R-1, 70–71 cm; -82R-2, 59–60 cm; -81R-1, 53–60 cm; -69R-CC, 21–22 cm; -58R-CC, 14–16 cm; 143-866A-46R-1, 85–87 cm; -39R-1, 77–78 cm; and -31R-1, 92–94 cm.

**Geographic distribution.** This species was described from the Albain of Great Britain.

**Arenobulimina cochleata** Arnaud-Vanneau, 1980

(Pl. 1, Figs. 13, 14)
Arenobulimina cochleata Arnaud-Vanneau, 1980, pp. 446–450, pl. 53, figs. 4–10, pl. 81, figs. 9–21, text figs. 166, 167.

Description. Test small, conical, trochosiphral (maximum height, 0.55 mm; maximum diameter, 0.40 mm). Chambers inflated, progressively enlarging in size, four to five in the first whorl, and separated by depressed sutures. Umbilicus medium in size (Pl. 1, Fig. 13). Wall agglutinated, thick, microgranular calcareous. Aperture at base of apertural face but obscured.

Remarks. Five specimens observed in thin section are identical in overall morphology to the figured types.

Age and occurrence. Hauterivian to early Aptian (?), from Samples 143-865A-147R-1, 23–25 cm; -144R-1, 137–140 cm; -119R-1, 18–19 cm; and -1028R-1, 59–64 cm.

Known range. Hauterivian to Aptian.

Geographic distribution. This species, described from the lower Aptian of Vercors, France, is known from the margins of the Tethys in Switzerland, France, and Spain on the north, and from the Middle East and Italy on the south.

Arenobulimina sp. A

(Pl. 1, Figs. 21–23)

Description. Test minute, conical, trochosiphral (maximum height, 0.14 mm; maximum diameter, 0.10 mm), with a small umbilicus (Pl. 1, Figs. 22, 23). Chambers increase progressively in size with six to seven in the final whorl, separated by depressed sutures. Wall agglutinated, thin, microgranular calcareous. Aperture at base of apertural face.

Remarks. About 10 specimens were observed in thin section that are smaller than previously described species of Arenobulimina.

Age and occurrence. Early Aptian (?), from Samples 143-865A-90R-1, 62–63 cm; -90R-1, 61–62 cm; -90R-1, 45–47 cm; -90R-1, 21–22 cm; and -90R-1, 13–14 cm.

Genus PRAECHYSLADINA Luperto Sinni, 1979

Praechyrsalidina infractetacea Luperto Sinni, 1979

(Pl. 2, Fig. 1)

Praechyrsalidina infractetacea Luperto Sinni, 1979, pp. 6–16, pl. 1, figs. 1–9, pl. 2, figs. 1–8, pl. 3, figs. 1–6.

Description. Test high trochospiral, conical, triserial throughout (maximum height, 1.15 mm) with chambers that increase rapidly in size. Sutures depressed. Wall agglutinated, thick, microgranular calcareous. Aperture a slit at base of a cribrate apertural plate.

Remarks. Four specimens were observed in thin section. Fine striae parallel to the test surface that typify the species were not identified in the Pacific specimens.

Age and occurrence. Albian, from Samples 143-865A-90R-1, 62–63 cm; -90R-1, 61–62 cm; -90R-1, 45–47 cm; -90R-1, 21–22 cm; and -90R-1, 13–14 cm.

Genus PRAECHYSLADINA Luperto Sinni, 1979

Praechyrsalidina infractetacea Luperto Sinni, 1979

(Pl. 2, Figs. 21–23)

Description. Test small, conical, trochosiphral (maximum height, 0.30 mm). Chambers decrease in number from three to two per whorl, subdivided by two to three radial beams.

Remarks. The two specimens observed in thin section differ from species A in their smaller size, fewer initial chambers per whorl, and fewer beams subdividing the chambers.

Age and occurrence. Probable Barremian, from Sample 143-866A-129R-1, 52–54 cm.

Family NEZZAZATIDAE Hamessi and Saint-Marc, 1970

Subfamily NEZZAZATINAE Hamessi and Saint-Marc, 1970

Genus NEZZAZATA Omara, 1956

Nezzazata isabellae Arnaud-Vanneau and Sliter, n. sp.

(Pl. 7, Figs. 2, 11–24)

Description. Test has a low trochospiral, biconvex, spiral side more convex than umbilical side, periphery rounded, umbilicus closed (maximum size, 0.14 mm; maximum diameter, 0.20 mm). Protoconch rounded, at apex of the dorsal face, followed by two to three whorls of up to 12 chambers per whorl, separated by slightly depressed sutures. Variation in test size and chamber number in the final whorl may result from dimorphism. Wall of microgranular calcite, imperforate. Aperture extends from the umbilicus to the periphery, then bends parallel to the peripheral margin, with an apertural tooth and toot plate that extends back in the direction of the previous aperture.

Remarks. More than 100 specimens were observed in thin section and as isolated specimens. Comparison of the present specimens to previously described species shows different differences. Nine species of Nezzazata are described from the Cenomanian to the Turanian: N. simplex Omara, N. gyra (Smout), N. conica (Smout), N. depressa (Smout), N. convessa (Smout), N. perforata (Smout), N. glomerulata (Smout), N. calcarata (Smout), and N. conoma Omara and Hataba. All the species described by Smout are larger in size than N. isabellae (two to three times larger), differ in shape, and have a very well-developed tooth plate that extends to the previous aperture. Nezzazata conoma is somewhat bigger than N. isabellae, but differs in having a concave umbilical side. The Hauterivian species Nezzazata simplex germanica Omara and Strauch is poorly described and may be incorrectly assigned to Nezzazata. Thus, Nezzazata isabellae probably represents one of the oldest species belonging to the genus.


Holotype. USNM 483970, axial thin section (Pl. 2, Fig. 11).

Type locality. Allison Guyot, Sample 143-865A-87R-1, 32–34 cm.

Age and occurrence. (Late?) Aptian to early Albian, from Samples 143-865A-90R-1, 62–63 cm; -90R-1, 61–62 cm; -90R-1, 45–47 cm; -90R-1, 44–45 cm; -90R-1, 13–14 cm; -89R-1, 13–15 cm; -87R-1, 92–95 cm; -87R-1, 63–66 cm; -87R-1, 32–34 cm; -86R-2, 116–117 cm; -86R-1, 16–20 cm; -75R-1, 2–3 cm; -17X-CC, 34–35 cm; 143-866A-35R-1, 88–90 cm; and -30R-CC, 0–1 cm.

Derivatio nominis. The species is dedicated to Professor Isabella Premoli Silva, University of Milano, Italy, co-chief of Leg 144.

Nezzazata sp. A

(Pl. 2, Figs. 8–10)

Description. Test to low trochospiral, slightly biconvex, umbilicus closed, periphery acute (maximum height, 0.12 mm; maximum diameter, 0.25 mm). Protoconch obscured, followed by a minimum of two whorls of chambers with up to seven chambers per whorl, separated by slightly depressed sutures (Pl. 2, Fig. 10). Aperture having a tooth plate that extends in the direction of the previous aperture.

Remarks. About 10 specimens were observed in thin section that differ from N. isabellae in being somewhat larger and having an acute periphery.

Age and occurrence. Late Aptian, from Samples 143-865A-34R-1, 85–86 cm; 143-866A-8R-CC, 12–13 cm; -4M-1, 30–32 cm; and 143-866B-4R-1, 2–4 cm.

Nezzazata sp. B

(Pl. 2, Figs. 8–10)

Description. Test small, low trochospiral, spiral side more convex than umbilical side, periphery rounded, umbilicus closed (maximum height, 0.10 mm; maximum diameter, 0.18 mm). Protoconch rounded, followed by three or more whorls of chambers, with 10 chambers visible per whorl, that increase very gradually in size, separated by slightly depressed sutures (Pl. 2, Fig. 25).

Remarks. About 15 specimens were observed in thin section. Nezzazata sp. B is one of the smaller forms of Nezzazata. Despite the small size, chambers are numerous and increase slowly in size. The same species is also known from the upper Aptian of the Aquitaine Basin and in the lower to middle (?) Albain of Mexico and Venezuela (AAV, pers. observ., 1982, 1992, 1994).
**Nezazatidae gen. et sp. indet.**

(PL 2, Figs. 6, 7)

**Description.** Test a low trochospiral, spiral side more convex than umbilical side, periphery rounded, umbilicus closed (maximum height, 0.20 mm; maximum diameter, 0.35 mm). Protoconch rounded, followed by three whorls of chambers with nine chambers visible per whorl that increase rapidly in size, separated by slightly depressed sutures (PL 2, Fig. 7). Apertural tooth plate indistinct.

**Remarks.** About 35 specimens observed in thin section are tentatively assigned to the genus *Nezazata* owing to the lack of a clearly defined tooth plate. These specimens are larger and have chambers that increase more rapidly in size than younger nezazatids found at Sites 865 and 866. Similar specimens from the Barremian to Aptian of France and Spain have been referred to *Valvulineria* (Arnaud-Vanneau, 1980).

**New emendation.**

**Geographic distribution.** The species is widespread along the margins of the Tethys.

**Family CUNEOLINIDAE Saidova, 1981**

**Genus VERCORSELLA Arnaud-Vanneau, 1980, emend.**

**New emendation.**

**Description.** Test small, conical (maximum height, 0.60 mm; maximum diameter, 0.30 mm) with an apical angle that varies from 25° to 30° in axial section parallel to the plane of biseriality. Initial trochospiral stage consists of rounded protoconch, small deuteroconch, and one or two chambers (PL 1, Figs. 5-9), followed by biserial stage with up to six chambers that are slightly compressed parallel to the plane of biseriality and subdivided by four to five radial beams that extend from the outer wall toward the plane of biseriality. Horizontal rafters are not present. Wall of biseral stage microgranular. Aperture a row of rectangular pores at the base of the septal face.

**Remarks.** About 40 specimens were observed as isolated specimens and in both oriented and random thin sections. The Pacific specimens differ from typical *Vercorrella arenata* in being smaller, less compressed, and having
A. ARNAUD-VANNEAU, W.V. SLITER

fewer vertical partitions in chambers of the biserial stage. The test is microgranular only and not arenaceous.

Age and occurrence. Albian, common in Sections 143-865A-89R-1 to -75R-1, and Sections 143-866A-77R-3 to -4R-1.

Known range. Barremian to Albian.

Geographic distribution. Although known from the margins of the Tethys, the species occurs predominantly along the northern margin in Romania, Switzerland, France, and Spain.

Vercorsella sp. cf. V. immutata He, 1982

(Pl. 2, Figs. 31–34)

Description. Test small, conical (maximum height, 0.35 mm; maximum diameter, 0.18 mm), apical angle varies from 15° to 28° in axial section parallel to the plane of biserality. Embryonic apparatus formed by a rounded protoconch and a large deuterococonch. The biserial stage with up to nine rows of chambers that are slightly compressed parallel to the plane of biserality and divided by two or three short radial beams that extend less than halfway to the plane of biserality and are thinned toward the center. Horizontal rafters are not present. Wall microgranular.

Remarks. About 30 specimens were observed in thin section. The Pacific specimens differ from typical Vercorsella immutata in having a more acute apical angle, and fewer and shorter radial beams in the chambers of the biserale stage.

Age and occurrence. Late(?) Aptian, from Samples 143-866A-78R-3, 90-91 cm; -76R-3, 15–15.5 cm; -75R-3, 113–115 cm; and -75R-2, 1–3 cm.

Known range. Aptian to Albian.

Geographic distribution. The species was previously restricted to Xi-zang, Tibet.

Vercorsella sp. cf. V. scarsellai De Castro, 1963

(Pl. 3, Figs. 1-4)

Description. Test small, elongate, conical (maximum height, 1.05 mm; maximum diameter, 0.3 mm), apical angle varies from 15° to 28° in axial section parallel to the plane of biserality. Initial trochospiral stage consists of a rounded protoconch, a small deuterococonch, and one chamber (Pl. 3, Fig. 1), followed by a biserial stage with up to eight chambers, slightly compressed parallel to the plane of biserality and divided by a maximum of four radial beams. Horizontal rafters are lacking. Aperture a row of rectangular pores at base of sepal face.

Remarks. About 30 specimens were observed in thin section. The Pacific specimens differ from typical Vercorsella scarsellai in being smaller and having fewer chambers and fewer but thicker radial beams.

Age and occurrence. Late Aptian, from Section 143-865A-89R-6 to -47R-CC and Section 143-866A-47R-1 to -15R-CC.

Known range. Barrenian to Albian.

Geographic distribution. The species is known from the southern margin of the Tethys in Italy, Croatia, Slovenia, North Africa, and the Middle East.

Vercorsella wintereri Arnaud-Vanneau and Sliter, n. sp.

(Pl. 3, Figs. 10-17)

Description. Test minute, conical (maximum height, 0.30 mm; maximum diameter, 0.15 mm), apical angle varies from 20° to 30° in taloral section parallel to the plane of biserality. Initial trochospiral stage not observed. Chambers either not compressed or slightly compressed perpendicular to the plane of biserality, subdivided by up to five very short radial beams that extend nearly to the outer wall (Pl. 3, Figs. 16, 17). Horizontal rafters are not present. Wall microgranular.

Aperture indistinct.

Remarks. About 70 specimens were observed in thin section. Vercorsella wintereri is the only species assigned to the genus that lacks compression of the chambers in the biseral stage or shows compression perpendicular to the plane of biserality. In addition, this species has the shortest radial beams yet described, which makes identification difficult in axial sections and requires further examination in subaxial, tangential, or radial sections.


Holotype. USNM 483971, subaxial section (Pl. 3, Fig. 10).

Type locality. Resolution Guyot, Sample 143-866A-153R-2, 20–22 cm.

Age and occurrence. Late Aptian, from Samples 143-865A-34R-CC, 15–16 cm; -34R-1, 118–119 cm; -34R-1, 101–102 cm; -34R-1, 85–86 cm; -31R-CC, 2–3 cm; -29R-CC, 2–3 cm; -19R-CC, 3–4 cm; 143-866A-20CC, 3–4 cm; -17R-CC, 2–3 cm; -15R-CC, 2–3 cm; -12R-CC, 2–3 cm; -11R-CC, 3–4 cm; 143-866B-5M-1, 5–7 cm; -4M-1, 30–32 cm; and 143-866B-1R-2, 15–17 cm.

Known range. Albian to Cenomanian, Santonian(?).

Geographic distribution. The species is mostly known from the southern margin of the Tethys in the Middle East, Egypt, Greece, Italy, Albania, Yugoslavia, and North Africa, and from the southern margin in France and Spain.

Cuneolina pavonia D'Orbigny, 1839

(Pls. 4, Figs. 1–5)

Cuneolina pavonia D'Orbigny; Grötsch, 1991, pl. 19, fig. 5.

Description. Test compressed, flabelliform (maximum height, 1.8 mm; maximum diameter, 0.4 mm), with a small initial trochospiral stage followed by a larger biseral stage. Chambers broad, divided by numerous radial beams that thin toward the plane of biserality and two to three transverse rafters. Interior divided into network of rectangular chambers along the outer wall. Wall kerothecal microgranular, with very small, tubular alveolae.

Remarks. About 15 specimens were observed in mostly tangential or transverse thin sections. We attribute these large specimens with a very large embryonic apparatus divided by many beams and rafters to this species (Pls. 4, Figs. 4, 5). The Pacific specimens are smaller and have a thinner, less agglutinated wall than typical Cuneolina pavonia and may represent another species. However, without whole specimens and more definitive thin sections, we presently cannot distinguish these specimens from Cuneolina pavonia.

Age and occurrence. Late Aptian, from Samples 143-865A-26R-CC, 2–3 cm; 143-866A-15R-CC, 12–14 cm; -9R-CC, 1–2 cm; -6R-CC, 17–19 cm; 143-866B-10R-CC, 41–43 cm; -7R-CC, 6–9 cm; -5M-CC, 39–41 cm; and 143-867B-13R-CC, 20–22 cm.

Known range. Albian to Santonian.

Geographic distribution. The species is known along the southern margin of the Tethys in the Middle East, Egypt, Greece, Italy, Albania, Yugoslavia, and North Africa, and from the northern margin in France and Spain.

Cuneolina parva Hausen, 1948

(Pl. 4, Figs. 6–9)

Cuneolina parva var. parva nov. Hausen, 1948, pp. 624–627, pl. XIV, figs. 1–6, pl. XVII, figs. 7–12, pl. XVIII, figs. 12–14.

Cuneolina laurantii Sartoni and Crescenti; Shiba, 1988, pl. 7, figs. 25–28.

Cuneolina d'Orbigny; Grötsch, 1991, pl. 19, figs. 3, 47, 6–8.

Description. Test compressed, conical to flabelliform (maximum height, 1.3 mm; maximum diameter, 0.9 mm). Embryonic apparatus composed of a large, oval, protococonch covered by a deuterococonch divided by beams and rafters, followed by a broad, low, biseral stage with up to 12 chambers. Chambers compressed parallel to the plane of biserality and divided by radial beams and one or two transverse rafters that produce a rectangular network of chamberlets. Wall kerothecal, microgranular, and composed of small, tubular alveolae. Aperture a row of rectangular pores at base of sepal face.

Remarks. The Pacific taxon, represented by about 20 specimens examined whole and in thin section, is similar to the types of Cuneolina parva described from the Santonian of Egypt. The published age of the type locality, however, is incorrect and, instead, probably is Albian (A.I. Kenawi, pers. comm., 1991).

Age and occurrence. Late(?) Aptian, from Samples 143-865A-34R-CC, 15–16 cm; -34R-1, 118–119 cm; -34R-1, 101–102 cm; -34R-1, 85–86 cm; -31R-CC, 2–3 cm; -29R-CC, 2–3 cm; -19R-CC, 3–4 cm; 143-866A-20CC, 3–4 cm; -17R-CC, 2–3 cm; -15R-CC, 2–3 cm; -12R-CC, 2–3 cm; -11R-CC, 3–4 cm; 143-866B-5M-1, 5–7 cm; -4M-1, 30–32 cm; and 143-866B-1R-2, 15–17 cm.

Known range. Albian to Cenomanian, Santonian(?).

Geographic distribution. The species is mostly known from the southern margin of the Tethys in the Middle East, Egypt, Greece, Italy, Albania, Yugoslavia, and North Africa, and from the northern margin in France and Spain.

Cuneolina sp. A

(Pl. 4, Figs. 10, 11)

Description. Test small, slightly compressed, conical (maximum height, 0.65 mm; maximum diameter, 0.35 mm). Embryonic apparatus formed by a
small, oval protoconch, slightly tilted, and a deuteroconch divided by a few rafters and beams, followed by short biserial stage with up to five or six chambers slightly compressed parallel to the plane of biserality. Chambers divided by radial beams that thin toward the center, horizontal rafters lacking. Wall keriothecal, microgranular, with very small, tubular alveoles. Aperture a row of elongate pores at base of septal face.

Remarks. About 20 to 30 specimens of this apparently new species were observed whole and as oriented and random thin sections. The Pacific form is the smallest cuneolinid described and probably the oldest. The conical test is triangular and never flabelliform as are Cuneolina parva or Cuneolina pa-vonia. The deuteroconch displays only a few beams and rafters, and sometimes only one is visible in thin section. Chambers are divided by only radial beams, and the specimens lack the horizontal rafters.

Age and occurrence. Albian, common from Sections 143-865A-88R-1 to -Tb, and Sections 143-866A-45R-CC to -11R-CC.

Family ORBITOLINIDAE Martin, 1890
Subfamily DICOTYCONINAE Moullade, 1965
Genus Paracoskinolina Moullade, 1965
Paracoskinolina sp. cf. P. sunnilandensis (Maync) (Pl. 4, Figs. 14-16)
Coskinolina sunnilandensis Maync, 1955, pp. 106, pl. 16, fig. 1.

Description. Test small, high conical (apical angle from 35° to 40°), with a flat base (maximum height, 0.7 mm; maximum diameter, 0.5 mm). Embryonic apparatus indistinct. Chamber margin divided by radial beams that thicken slightly toward center of test; transverse rafters lacking. Central zone divided by pillars that appear continuous from one chamber to the next (Pl. 4, Fig. 14).

Remarks. The Pacific specimens, represented by 15 thin sections, differ slightly from the type specimens as follows: 1) the morphology of the embryonic apparatus consists of a protoconch and a deuteroconch, followed by bilobate chambers that form a short trochospire; and 2) the absence of alternating first-order radial beams in the marginal zone. First-order radial beams do not alternate between chambers. Radial zone divided by radial zigzag partitions that thicken and become triangular in axial or subaxial sections; partitions alternate regularly from one chamber to the next in contrast to first-order beams of the radial zone.

Age and occurrence. Probable Albian (middle to late?), from Sample 143-866A-47R-1, 60-72 cm.

Orbitolinid B

Remarks. About 15 specimens of orbitolinids observed in subaxial, tangential, and oblique thin sections were not assigned to genus or species owing to the poor quality of the material. The specimens are of interest as the stratigraphic distribution of orbitolinids is limited.

Age and occurrence. Probable Albian (middle to late?), from Samples 143-865A-47R-1, 84-86 cm; -46R-1, 84-86 cm; 143-866A-57R-1, 80-82 cm; -46R-2, 14-16 cm; -39R-1, 23-24 cm; -35R-1, 129-130 cm; and -35R-1, 88-90 cm.

Family INVOLUTINIDAE Bütschli, 1880
Genus TROCHOLINA Paalzow, 1922
Trocholina sp. cf. T. lenticalaris Henson, 1947 (Pl. 5, Fig. 1)

Description. Test low conical (apical angle, 130°; diameter, 1.2 mm), protocochna indistinct, sections of the following tubular second chamber are triangular in the figured subaxial section and strongly eroded, unhisbical side slightly convex. Wall calcareous, very thin, eroded in figured specimen.

Remarks. A single specimen was observed in thin section that is similar in morphology and size to specimens of Trocholina lenticalaris illustrated by Arnaud-Vanneau, Boisseau, and Darsac (1988, pl. 6, figs. 22-27). The poor preservation of the recovered specimen and the lack of additional material, however, prevent definitive assignment to this species.

Age and occurrence. Late (?) Albian, from Sample 143-865A-51R-CC, 11-13 cm.

Known range. Late Albian to early Cenomanian.

Geographic distribution. This species was previously restricted to the southern margin of the Tethys in the Middle East.

Trocholina molesta Gorbatchik, 1959 (Pl. 5, Fig. 6)

Trocholina molesta Gorbatchik, 1959, pp. 79-91, pl. 4, figs. 1-2. Trocholina molesta Gorbatchik; Arnaud-Vanneau, Boisseau, and Darsac, 1988, p. 359, fig. 3, pl. 6, figs. 11-21.

Description. Test small, low conical (apical angle, 110°; diameter, 0.4 mm), protocochna indistinct, tubular second chamber showing four whorls,
umbilical side slightly convex. Wall calcareous, outer wall moderately thick, partly eroded in figured specimen.

Remarks. A single specimen observed in thin section is similar in morphology and size to typical specimens of *Trocholina molesta*. However, prevented us from confirming our identification of this species, which resemble *Neotrocholina infragranulata*. The paucity of thin sections, how-

**Age and occurrence.** Probable Hauterivian, from Samples 143-866A-147R-1, 22–25 cm.

**Known range.** Tithonian to Barremian.

**Geographic distribution.** This species, described from the Berriasian of the Crimea, is known along the northern margin of the Tethys from the Crimea to Spain.

*Trocholina sp. cf. T. odukpaniensis* Dessauvagie, 1968

(PL. 5, Fig. 7)

**Description.** Test small, low conical (apical angle, 95° to 110°; maximum diameter, 0.7 mm), eroded. Protoconch indistinct, tubular second chamber with four whorls visible, subaxial section of tubular chamber shows triangular section that bends slightly toward umbilical side, umbilical side flat to slightly convex.

Remarks. Two specimens were observed in thin section that closely resemble *Neotrocholina fruegerensis* and have a umbilical side slightly convex. These specimens may represent juveniles; however, with the present limited material, we cannot confirm the identification.

**Age and occurrence.** Late Albian, from Samples 143-865A-34R-1, 40–42 cm, and -5R-CC, 15–16 cm.

**Known range.** Late Albian to early Cenomanian.

**Geographic distribution.** This species was described from the upper Albian to lower Cenomanian of Nigeria and is reported from the margins of the Tethys.

**Genus NEOTROCHOLINA** Reichel, 1956

*Neotrocholina sp. cf. N. friburgensis* Guillame and Reichel, 1957

(PL. 5, Figs. 2, 3)

**Description.** Test conical (apical angle, about 90°; maximum diameter, 0.62 mm) with a thick yellow calcitic crust. Protoconch indistinct, Second chamber tubular, broad, triangular in subaxial section (PL. 5, Fig. 2), trocho-

Remarks. Five specimens were observed in thin section. These specimens are similar in morphology, although smaller, to specimens of *Trocholina odukpaniensis*. These specimens may represent juveniles; however, with the present limited material, we cannot confirm the identification.

**Age and occurrence.** Late Albian, from Samples 143-866A-145R-1, 22–26 cm.

**Known range.** Late Barremian to the base of the early Aptian.

**Geographic distribution.** The species was originally described from Switzerland and is also known in France and Romania.

*Neotrocholina sp. cf. N. infragranulata* Noth, 1951

(PL. 5, Figs. 4, 5)

**Description.** Test low conical (apical angle from 125° to 135°; maximum diameter, 0.40 mm) with a thick yellow calcitic crust (PL. 5, Fig. 5). Protoconch indistinct. Second chamber tubular, triangular in subaxial section with a small acute angle toward the center of the test (PL. 5, Fig. 4), trochospherally enrolled in four whorls. Umbilical side flat, with characteristic marginal ridge and numerous small pillars (PL. 5, Fig. 5).

Remarks. Four specimens were observed in thin section that closely resemble *Neotrocholina infragranulata*. The paucity of thin sections, however, prevented us from confirming our identification of this species, which originally was described from whole specimens.

**Age and occurrence.** Hauterivian to Barremian, from Samples 143-866A-157R-1, 11–14 cm; -156R-1, 81–85 cm; -115R-1, 22–26 cm; and -125R-1, 67–69 cm.

**Known range.** Hauterivian to Barremian.

**Geographic distribution.** This widespread species was originally described from the Hauterivian of Austria.

Family VENTROLAMINIDAE Weyschenschek, 1950

*Protoheropora* sp.

(PL. 5, Figs. 8–10)

**Description.** Test low trochospherally lenticular, planovex convex to biconvex, spiral side more convex than umbilical side, periphery subacute (maximum height, 0.30 mm; maximum diameter, 0.45 mm). Chambers in minimum of two whorls. Sutures probably pustulate or ornamented (PL. 5, Fig. 10). Wall calcareous and composed of two layers; a microgranular inner layer and a hyaline outer layer that increases in thickness toward the initial chamber. Thickenings on spiral side forms calcitic button visible in axial or subaxial section (PL. 5, Fig. 10); surface ornamentation indistinct. Aperture indistinct.

Remarks. Seven specimens were observed in thin section that are the same size as *Protopenopora ultragranulata* Gorbatchik from the Berriasian of the Crimea, but differ in being less ornamented.

**Age and occurrence.** Probable Barremian, from Samples 143-866A-127R-1, 25–27 cm; -126R-1, 70–72 cm; -125R-3, 19–21 cm; -125R-2, 70–72 cm; and -125R-1, 143–145 cm.

*Family HAURERINIDAE* Schwager, 1876

Subfamily SIPHONAPERTINAE Saidova 1975

*Genus RUMANOLOCULINA* Neagu, 1984

*Rumanoiloculina sp. cf. R. minima* Tappan, 1943

(PL. 5, Fig. 12)

**Description.** Test globular. Chambers with floors, in millillion arrangement, forming successive Y-shaped cycles 90° apart, separated by depressed sutures, five chambers visible externally. Wall calcareous, imperforate, porcelaneous. Aperture indistinct.

Remarks. About 20 specimens were observed in thin section that precluded the determination of the surface ornamentation.

**Age and occurrence.** Albian, from Samples 143-866A-47R-1, 66–68 cm; -46R-2, 14–16 cm; -46R-1, 85–87 cm; -45R-CC, 23–25 cm; -37R-1, 77–78 cm; and -35R-1, 88–90 cm.

**Known range.** Aptian to Albian.

**Geographic distribution.** This species was described from the Albian of Texas and is found along the margins of the Tethys.

*Rumanoiloculina robusta* (Neagu), 1968, p. 566, pl. 1, figs. 8–17, pl. 7, figs. 1–3.

*Rumanoiloculina robusta* Neagu, 1968, p. 315, pl. 7, figs. 23–25, pl. 8, figs. 30–38, text-fig. 2.

**Description.** Test large, globular. Chambers quinqueloculine in arrangement, forming successive Y-shaped cycles less than 90° apart, with six, five chambers visible externally, separated by strongly depressed sutures. Wall calcareous, imperforate, porcelaneous. Aperture indistinct.

Remarks. About 20 specimens were observed in thin section.

**Age and occurrence.** Barremian to early Aptian, from Samples 143-866A-126R-1, 79–80 cm; -78R-3, 90–91 cm; -77R-1, 117–122 cm; -77R-3, 91–93 cm; -71R-2, 37–41 cm; -70R-2, 21–23 cm; and -68R-CC, 5–7 cm.

**Known range.** Barremian to early Aptian.

**Geographic distribution.** This species, described from the Berriasian of Romania, is known along the margins of the Tethys.

*Genus ISTRILOCULINA* Neagu, 1984

*Istriloculina sp. cf. I. elliptica* (loveccheva)

(PL. 5, Figs. 13, 15, 17, 18)

*Pyrgo ellipticus* locovecheva, 1962, pp. 52, pl. 2, fig. 7.

**Description.** Test elongate, ovate, thin. Chambers arrangement Y-shaped, without floors, three chambers are visible externally, two chambers on one side, and one on the opposite, separated by slightly depressed sutures. Wall very thin, calcareous, imperforate, porcelaneous. Aperture indistinct.

Remarks. More than 30 specimens observed in thin section. The type specimens of *Istriloculina elliptica*. Species of *Istriloculina* are widespread in restricted Cretaceous environments and are generally attributed to the genus *Pseudotriloculina* Cherif, 1970 (e.g., Arnaud-Vanneau, 1980). This taxonomic placement is incorrect, however, and the Cretaceous forms are now assigned to *Istriloculina*, which was subsequently described by Neagu in 1984.

**Age and occurrence.** Hauterivian (7) to Barremian, from Samples 143-866A-147R-1, 23–25 cm; -126R-1, 79–80 cm; -111R-1, 121–122 cm; -91R-1, 73–74 cm; -89R-1, 81–82 cm; -78R-3, 90–91 cm; and -77R-3, 117–122 cm.

**Known range.** Hauterivian to early Aptian.

**Geographic distribution.** *Istriloculina elliptica* was described from the Aptian of Bulgaria and is found along the margins of the Tethys.
Genus **DECUSSOLOCULINA** Neagu, 1984

*Decussoloculina* sp. cf. *D. mirceai* Neagu, 1984
(Pl. 5, Fig. 19)

**Description.** Test minute, elliptical. Chambers initially in miliolino arrangement, then form X-shaped pattern, without floors, separated by depressed sutures. Axial thin sections show external spiral disposition of chambers on opposite sides. Wall calcareous, imperforate, porcelaneous. Aperture indistinct.

**Remarks.** Three small specimens observed in thin section probably represent juvenile forms. As a result, we are unsure of the correct taxonomic placement of these rare Pacific forms.

**Age and occurrence.** Probable Hauterivian, from Sample 143-866A-171R-1, 21–24 cm.

**Known range.** Late Berriasian to Valanginian.

**Geographic distribution.** This species, described from the Valanginian of Romania, is found along the northern margin of the Tethys in Switzerland, France and Spain.

Subfamily SIGMOILINITINAE Luczkowska, 1974

Genus **PSEUDONUMMOLOCULINA** Calvez, 1988

*Pseudonummoloculina* sp.
(Pl. 5, Fig. 11)

**Description.** Test discoidal. Protoconch surrounded entirely by flexostyle canal, followed by miliolino stage, then becomes nearly planispiral, final whorl with two chambers. Wall calcareous, porcelaneous. Aperture probably areal.

**Remarks.** A single specimen was observed in thin section. The genus *Pseudonummoloculina* is represented by three species: *P. aurigerica* Calvez from the early to middle Albian of the Pyrenees, France; *P. heimi* (Bonet) from the Albian to Cenomanian of Mexico; and *P. robusta* (Torre) from the Senonian of Italy. The Pacific pseudonummoloculid is a very small form and apparently represents juvenile forms. As a result, we are unsure of the correct taxonomic placement of these rare Pacific forms.

**Age and occurrence.** Probable Albian(?), from Sample 143-866A-46R-1, 104–106 cm.

**Class CRUSTACEA** Pennant, 1777

**Order DECAPODA** Latreille, 1803

**Family AXIIDAE** Huxley, 1879

*Palaxius salataensis* Senowbari-Daryan and Grötsch, 1992


**Description.** Elongate coprolites (diameter, 0.4–0.45 mm). Transverse section shows up to four strongly curved, crescent-shaped canals with enlarged tips. Canals usually open toward the center of the pellet.

**Remarks.** Twelve specimens were observed in thin section that apparently represent a new Pacific species of *Palaxius*, with canals bigger and more crescent-shaped than in *Palaxius salataensis*.

**Age and occurrence.** Late Aptian(?) to early Albian(?) from Sample 143-865A-87R-2, 102–104 cm.

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APPENDIX

Faunal Reference List

Ammobaculoides sp.
Arenobilinina sp. cf. A. chapmani Cushman
Arenobilinina coehleata Arnaud-Vanneau
Arenobilinina sp. A
Barherina sp. cf. B. barherensis Frizzell and Schwartz
Belorussiella testulitrioides (Reuss) (= Bolivina textularioides Reuss)
Bucurestina hedbergi (Mayne) (= Pseudocyclusina hedbergi Mayne)
Canpahnelia capensis De Castro
Cueneolina parva Henson
Cueneolina sp. cf. C. pavonia d’Orbigny
Cueneolina sp. A
Deburina sp. cf. D. khoumerensis Fourcade, Raoult, and Vila

Decusloculina sp. cf. D. mirceai Neagu
Falsurgonina(? ) sp.
Favreina sp. cf. F. prusensis (Paréjas) (= Coprolithus prusensis Paréjas)
Istriloculina sp. cf. I. elliptica (Iovcheva) (= Pyrgo elliptique Iovcheva)
Melathrocerion sp. cf. M. valserinensis Brönnimann and Conrad
Neirihotia(? ) sp.
Neotrocholina sp. cf. N. frisburgerensis Guillame and Reichel
Neotrocholina sp. cf. N. infragranulata Nöth
Nezzazata isabellae Arnaud-Vanneau and Sliter, n. sp.
Nezzazata sp. A
Nezzazata sp. B
Nezzazata(?) sp. C
Novalesia angulosa (Magniez) (= Spiroplectamminoides angulosa Magniez)
Novalesia producta (Magniez) (= Spiroplectamminoides productus Magniez)
Orbitolinid A
Orbitolinid B
Palaxius salataensis Senowbari-Daryan and Grötsch
Palaxius sp. A
Paracanskiolina sp. cf. P. sunnilandensis (Mayne) (= Coskinolina sunnilandensis Mayne)
Preachrysidae infracretacea Luperto Sinni
Protopeneroplis sp.
Pseu donnum loculina sp.
Rumanoloculina sp. cf. R. minima Tappan
Rumanoloculina robusta (Neagu) (= Quinqueloculina robusta Neagu)
Sabaudia minuta (Hofker Jr.) (= Textulariella minuta Hofker Jr.)
Trocholina sp. cf. T. lenticularis Henson
Trocholina molesta Gorbatchik
Trocholina sp. cf. T. oduspaniensis Dessauvage
Valvulineria(?) sp. 1
Vercorsetta sp. cf. V. arenata Arnaud-Vanneau
Vercorsetta sp. cf. V. immaturata He
Vercorsetta sp. cf. V. scarsellai De Castro
Vercorsetta wintereri Arnaud-Vanneau and Sliter, n. sp.
Voloshinoidec(?) sp. A
Voloshinoidec(?) sp. B
Plate 1. Thin-section micrographs of Early Cretaceous benthic foraminifers from Leg 143. Specimen scale = 100 mm; *specimens in Figures 3, 4, and 5 = 200 mm.

Plate 2. Thin-section micrographs of Early Cretaceous benthic foraminifers from Leg 143. Specimen scale = 100 mm; *specimen in Figure 1 = 200 mm. 1. Praechrysalidina infracretacea, Sample 143-866A-47R-1, 94-96 cm. 2-4. Voloshinoides (?) sp. A; (2) Sample 143-865A-34R-1, 101-102 cm; (3) Sample 143-865A-73R-1, 9-10 cm; (4) Sample 143-865A-74R-1, 48-50 cm. 5. Voloshinoides (?) sp. B, Sample 143-866A-129R-1, 52-54 cm. 6, 7. Nezzazata (?) sp. C; (6) Sample 143-866A-78R-3, 90-91 cm; (7) Sample 143-866A-79R-3, 114-116 cm. 8-10. Nezzazata sp. A, Sample 143-865A-34R-1, 85-86 cm. 11-24. Nezzazata isabellae n. sp.; (11) holotype; (16, 18) Sample 143-865A-87R-1, 32-34 cm; (12, 17) Sample 143-865A-90R-1, 13-14 cm; (13, 23, 24) Sample 143-865A-90R-1, 45-47 cm; (14, 19, 20, 21) Sample 143-865A-90R-1, 44-45 cm; (15, 22) Sample 143-865A-90R-1, 62-63 cm. 25, 26. Nezzazata sp. B; (25) Sample 143-865A-88R-1, 13-15 cm; (26) Sample 143-866A-76R-3, 10-15 cm. 27-30. Valvulineria (?) sp. 1; (27, 28) Sample 143-866A-146R-1, 111-114 cm; (29) Sample 143-866A-147R-1, 23-25 cm; (30) Sample 143-866A-170R-4, 138-139 cm. 31-34. Vercorsella sp. cf. V. immaturata; (31) Sample 143-866A-78R-3, 90-91 cm; (32-34) Sample 143-866A-76R-3, 10-15 cm.
Plate 3. Thin-section micrographs of Early Cretaceous benthic foraminifers from Leg 143. Specimen scale = 100 mm; *specimen in Figure 19 = 200 mm. 1–4. Vercorsella sp. cf. V. scarsellai: (1) Sample 143-865A-87R-1, 63–66 cm; (2) Sample 143-865A-69R-CC, 21–22 cm; (3, 4) Sample 143-866A-47R-1, 66–68 cm. 5–9. Vercorsella sp. cf. V. arenata: (5) Sample 143-865A-79R-1, 27–28 cm; (6) Sample 143-865A-34R-1, 118–119 cm; (7) Sample 143-865A-89R-6, 28–32 cm; (8) Sample 143-866A-46R-2, 14–16 cm; (9) Sample 143-866A-46R-2, 41–43 cm. 10–17. Vercorsella wintereri n. sp.; (10) holotype, Sample 143-866A-153R-2, 20–22 cm; (11–13, 17) Sample 143-866A-166R-1, 97–100 cm; (14) Sample 143-866A-166R-1, 98–100 cm; (15) Sample 143-866A-157R-2, 84–86 cm; (16) Sample 143-866A-169R-3, 17–18 cm. 18. Falsurgonina(?) sp., Sample 143-866A-129R-6, 13–15 cm. 19, 20. Orbitolinid A; (19, 20) Sample 143-866A-47R-1, 60–70 cm.
Plate 4. Thin-section micrographs of Early Cretaceous benthic foraminifers from Leg 143. Specimen scale = 100 mm; *specimens in Figures 1–3, 6–9, and 13–16 = 200 mm.