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Late Campanian (Zone CC 22) Coccoliths from the Millhaven Core, Screven County, Georgia

By David Bukry

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GEOLOGY AND PALEONTOLOGY OF FIVE CORES FROM
SCREVEN AND BURKE COUNTIES, EASTERN GEORGIA

Edited by Lucy E. Edwards

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ABSTRACT

Coccolith floras from the Millhaven core in Screven County, Georgia, from depths of 1,077 to 968 feet, belong to late Campanian Zone CC 22. The co-occurrence of zonal guide species *Quadrum trifidum* (Stradner) Prins & Perch-Nielsen and *Reinhardtites anthophorus* (Deflandre) Perch-Nielsen permits direct correlation with the paleomagnetically dated Point Loma Formation in California. *Q. trifidum* (Stradner) Prins & Perch-Nielsen, a warm-water taxon, is consistently present in the Georgia and California sections but is missing from the late Campanian floras that occur in the northern Atlantic Coastal Plain in New Jersey.

INTRODUCTION

Four core samples were examined for coccolith content from the U.S. Geological Survey Millhaven test hole (lat 32°53'25" N., long 81°35'43" W.), which is located in Screven County, Ga. (fig. 1). These samples were studied to supplement biostratigraphic dating of the Cretaceous marine sediments in the core interval from the 1,099 to 927 ft. This Cretaceous interval is considered to be part of the Black Creek Group, which ranges in age from middle to late Campanian in the Millhaven core (Falls and Prowell, this volume, chap. A; Edwards and others, this volume, chap. B). Samples studied for this report represent all but the lowest 20 ft of the Black Creek Group subunit 2 of Falls and Prowell (this volume, chap. A). Comparative coccolith samples from New Jersey and California Cretaceous strata also were used in this study. The Californian floras have been published previously by Bukry and Kennedy (1969) and Bukry (1993, 1994). Coccoliths identified from the Millhaven core are listed in table 1, and all taxa considered in this report are listed in table 2.

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MATERIAL AND METHODS

Samples from the Millhaven core and outcrop samples from New Jersey and California were prepared for light-microscope examination (magnifications $\times 600$ and $\times 1560$) using the technique described in Bukry and Kennedy (1969). Zonal assignments are based on Perch-Nielsen (1985, p. 342), and stage assignments are based on Sissingh (1977) and Burnett and others (1992).

GEORGIA COCCOLITHS

Coccoliths from the Millhaven core (table 1) are slightly etched and common to abundant. Floras have moderate to high species diversity (number of species (n)=15 to 30). The most common species are dissolution-resistant *Micula decussata* Vekshina and *Reinhardtites anthophorus* (Deflandre) Perch-Nielsen. Other stratigraphic guide spe-

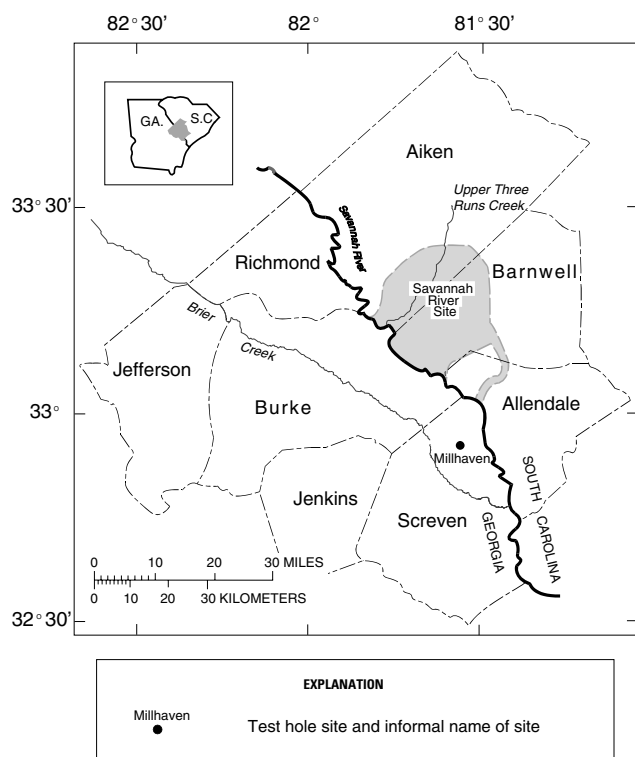


Figure 1. Index map showing the Savannah River Site and the location of the Millhaven test hole in Screven County, Georgia.

cies such as *Broinsonia parca* (Stradner) Bukry, *Calculites obscurus* (Deflandre) Prins & Sissingh, *Ceratolithoides aculeus* (Stradner) Prins & Sissingh, *Quadrum trifidum* (Stradner) Prins & Perch-Nielsen, and *R. levis* Prins & Sissingh are present in smaller numbers. All four of the closely spaced floras (1,077, 1,021.5, 971, and 968 ft) contain both *Q. trifidum* (Stradner) Prins & Perch-Nielsen and *R. anthophorus* (Deflandre) Perch-Nielsen, which together define late Campanian Zone CC 22. *Reinhardtites levis* Prins & Sissingh, which has been designated a guide species for upper Subzone CC 22b, occurs only rarely in the bottom and top samples. It is missing in the most diverse ($n=30$) sample at 1,021.5 ft. In the sample taken at 971 ft, only two specimens of *Reinhardtites* sp. cf. *R. levis* Prins & Sissingh were identified. Evidence from floras in California and Israel suggests that *R. levis* Prins & Sissingh has a longer range in CC 21 and CC 22 at middle latitudes (Bukry, 1994; Eshet and Moshkovitz, 1995). The best coccolith assignment for all four Georgia floras from the Millhaven core is late Campanian Zone CC 22.

NEW JERSEY COCCOLITHS

Outcrop and core samples from the Upper Cretaceous Mount Laurel Formation in New Jersey contain coccolith floras assigned to Subzone CC 22b (Sugarman and others,

1995). This late Campanian correlation is based on the identifications of key coccolith species *Broinsonia parca* (Stradner) Bukry, *Calculites obscurus* (Deflandre) Prins & Sissingh, *Reinhardtites anthophorus* (Deflandre) Perch-Nielsen, *R. levis* Prins & Sissingh, and *Tranolithus phacellus* Stover. The warm-water biostratigraphic guide species *Quadrum trifidum* (Stradner) Prins & Perch-Nielsen and *Quadrum sissinghii* Perch-Nielsen are missing from New Jersey floras (Bukry, 1990).

The absence of *Quadrum trifidum* (Stradner) Prins & Perch-Nielsen in New Jersey floras may be attributed to its general global distribution pattern and local ecological conditions. Roth (1978) described *Q. trifidum* (Stradner) Prins & Perch-Nielsen as a temperature-sensitive, warm-water species. Thierstein (1981, fig. 21) demonstrated maximum abundances within approximately 30 degrees latitude of the paleoequator for *Q. trifidum* (Stradner) Prins & Perch-Nielsen. Doeven (1983) used this information to suggest that in Canadian Atlantic well sites, the top range of *Q. trifidum* (Stradner) Prins & Perch-Nielsen might be depressed as a result of decreased paleotemperatures. Further, he reported only rare abundances at Canadian sites. Similarly, Burnett and others (1992) reported only sporadic occurrences of *Q. trifidum* (Stradner) Prins & Perch-Nielsen in sections from Germany and Poland. This occurrence pattern contrasts with the rare to common but consistent occurrences in California (Bukry, 1993, 1994) and the consistent presence in the Georgia core samples studied here.

Similar consistent occurrences were cited in Israel (Moshkovitz, 1984), supporting warm-water affinities for *Quadrum trifidum* (Stradner) Prins & Perch-Nielsen. The late Campanian Mount Laurel Formation floras from New Jersey lack *Q. trifidum* (Stradner) Prins & Perch-Nielsen but were assigned to Zone CC 22 or Subzone CC 22b based on the co-occurrence of other taxa, principally *Reinhardtites anthophorus* (Deflandre) Perch-Nielsen and *R. levis* Prins & Sissingh. The highest occurrence of *R. anthophorus* (Deflandre) Perch-Nielsen defines the top of Zone CC 22 in the late Campanian. In cooler water floras, the co-occurrence of *R. levis* Prins & Sissingh with *R. anthophorus* (Deflandre) Perch-Nielsen is considered a useful indicator for Subzone CC 22b (Perch-Nielsen, 1985, p. 347).

COMPARISON OF CAMPANIAN COCCOLITH FLORAS IN THE ATLANTIC COASTAL PLAIN AND CALIFORNIA

The Point Loma Formation in San Diego County, Calif., contains the same key coccolith species in late Campanian Zone CC 22 that occur in the Georgia floras. The consistent occurrence of *Quadrum trifidum* (Stradner) Prins & Perch-Nielsen in the Georgia floras matches the pattern in Point Loma core hole DH-1 where it occurs in 30 of 31 coccolith-bearing samples from CC 22 (Bukry, 1993). Both

Table 1. U.S. Geological Survey Millhaven core coccolith checklist.

Coccolith	Sample depth, in feet			
	1,077	1,021.5	971	968
<i>Arkhangelskiella cymbiformis</i> -----	X	X	X	--
<i>Biscutum</i> sp.-----	--	X	--	--
<i>Broinsonia parca parca</i> -----	X	X	--	X
<i>Broinsonia parca constricta</i> -----	X	X	--	--
<i>Calculites obscurus</i> -----	--	X	X	--
<i>Ceratolithoides aculeus</i> -----	X	X	X	X
<i>Chiastozygus amphipons</i> -----	--	X	--	--
<i>Chiastozygus</i> sp.-----	X	--	X	X
<i>Coronocyclus</i> sp.-----	--	X	--	--
<i>Cretarhabdus crenulatus</i> -----	X	X	X	X
<i>Cribrosphaera ehrenbergii</i> -----	X	X	--	X
<i>Eiffellithus eximius</i> -----	--	--	X	--
<i>Eiffellithus turriseiffelii</i> -----	X	--	X	--
<i>Gartnerago concavum</i> -----	--	X	--	--
<i>Gartnerago costatum</i> -----	--	X	--	X
<i>Kamptnerius magnificus</i> -----	X	X	X	--
<i>Lithraphidites carniolensis</i> -----	--	X	--	--
<i>Lucianorhabdus cayeuxii</i> -----	--	X	X	--
<i>Lucianorhabdus maleformis</i> -----	--	X	--	--
<i>Microrhabdulus decoratus</i> -----	--	X	--	X
<i>Micula concava</i> -----	--	--	--	X
<i>Micula decussata</i> -----	X	X	X	X
<i>Parhabdololithus embergeri</i> -----	X	X	X	X
<i>Prediscosphaera cretacea</i> -----	X	X	X	X
<i>Prediscosphaera spinosa</i> -----	--	--	--	X
<i>Quadrum sissinghii</i> -----	X	X	--	--
<i>Quadrum trifidum</i> -----	X	X	X	X
<i>Reinhardtites anthophorus</i> -----	X	X	X	X
<i>Reinhardtites levis</i> -----	X	--	--	X
<i>Reinhardtites</i> sp. cf. <i>R. levis</i> -----	--	--	X	--
<i>Rucinolithus</i> sp.-----	--	X	--	--
<i>Tranolithus phacelosus</i> -----	--	X	--	--
<i>Vagalapilla octoradiata</i> -----	X	X	--	--
<i>Watznaueria barnesae</i> -----	X	X	X	--
<i>Watznaueria biporta</i> -----	X	X	X	--
<i>Zygodiscus bicaescenticus</i> -----	X	X	X	--
<i>Zygodiscus spiralis</i> -----	--	X	--	--

sites are part of a warm-water regime, but the Point Loma flora lacks *Calculites obscurus* (Deflandre) Prins & Sissingh, *Kamptnerius magnificus* Deflandre, *Lucianorhabdus cayeuxii* Deflandre, and *Tranolithus phacelosus* Stover. These absences reflect deep-water deposition for the Point Loma core strata. In shallower water strata of the Point Loma Formation in Carlsbad, Calif., some *C. obscurus* (Deflandre) Prins & Sissingh and *L. cayeuxii* Deflandre were recorded (Bukry, 1994).

At La Jolla, Calif., floras assigned to CC 22b occur in a 280-ft stratigraphic section that has been assigned to mag-

netochronostratigraphic Chron 33n (Bannon and others, 1989, fig. 3) in the late Campanian (Bannon and others, 1989; Bukry, 1994). The key La Jolla coccoliths in the Chron 33n portion of Subzone CC 22b include *Broinsonia parca* (Stradner) Bukry, *Q. trifidum* (Stradner) Prins & Perch-Nielsen, *Q. sissinghii* Perch-Nielsen, *Reinhardtites anthophorus* (Deflandre) Perch-Nielsen, and *R. levis* Prins & Sissingh, which enable direct correlation of late Campanian paleomagnetic Chron 33n with the four Georgia floras assigned to the Black Creek Group. The disappearance of *R. anthophorus* (Deflandre) Perch-Nielsen in Europe predates

Table 2. Coccolith taxa considered in this report.

<i>Arkhangelskiella cymbiformis</i> Vekshina
<i>Broinsonia parca</i> (Stradner) Bukry
<i>Broinsonia parca constricta</i> Hattner et al.
<i>Calculites obscurus</i> (Deflandre) Prins & Sissingh in Sissingh
<i>Ceratolithoides aculeus</i> (Stradner) Prins & Sissingh in Sissingh
<i>Chiastozygus amphipons</i> (Bramlette & Martini) Gartner
<i>Cretarhabdus crenulatus</i> Bramlette & Martini
<i>Cribrosphaera ehrenbergii</i> Arkhangelsky
<i>Eiffellithus eximius</i> (Stover) Perch-Nielsen
<i>Eiffellithus turriseiffelii</i> (Deflandre) Reinhardt
<i>Gartnerago concavum</i> (Gartner) Bukry
<i>Gartnerago costatum</i> (Gartner) Bukry
<i>Kamptnerius magnificus</i> Deflandre
<i>Lithraphidites carniolensis</i> Deflandre
<i>Lucianorhabdus cayeuxii</i> Deflandre
<i>Lucianorhabdus maleformis</i> Reinhardt
<i>Microrhabdulus decoratus</i> Deflandre
<i>Micula concava</i> (Stradner in Martini and Stradner) Verbeek
<i>Micula decussata</i> Vekshina
<i>Parhabdolithus embergeri</i> (Noël) Stradner
<i>Prediscosphaera cretacea</i> (Arkhangelsky) Gartner
<i>Prediscosphaera spinosa</i> (Bramlette & Martini) Gartner
<i>Quadrum sissinghii</i> Perch-Nielsen
<i>Quadrum trifidum</i> (Stradner) Prins & Perch-Nielsen in Manivit
<i>Reinhardtites anthophorus</i> (Deflandre) Perch-Nielsen
<i>Reinhardtites levis</i> Prins & Sissingh
<i>Tranolithus phacelosus</i> Stover
<i>Vagalapilla octoradiata</i> (Gorka) Bukry
<i>Watznaueria barnesae</i> (Black) Perch-Nielsen
<i>Watznaueria biporta</i> Bukry
<i>Zygodiscus bicrescenticus</i> (Stover) Bukry
<i>Zygodiscus spiralis</i> Bramlette & Martini

the appearance of the cephalopod *Belemnella lanceolata* (basal Maastrichtian) (Burnett and others, 1992) and helps to confirm the late Campanian age for the correlated CC 22b coccolith floras on the Atlantic and Pacific coasts.

CONCLUSIONS

Millhaven core samples from 1,077 to 968 ft contain late Campanian Zone CC 22 coccolith floras identified by key taxa *Quadrum trifidum* (Stradner) Prins & Perch-Nielsen and *Reinhardtites anthophorus* (Deflandre) Perch-Nielsen. The consistent presence of *Q. trifidum* (Stradner) Prins & Perch-Nielsen indicates a warm-water regime similar to coeval California floras and unlike cooler water New Jersey floras. Coccolith species permit direct long-range correlation for Georgia floras to paleomagnetic Chron 33n in California and standard European upper Campanian reference sections.

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