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Late Maastrichtian rudist and coral assemblages from the Central Inlier, Jamaica: towards an event stratigraphy for shallow-water Caribbean limestones

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Abstract

The lithological succession of the Guinea Corn Formation in the Slippery Rock River, central Jamaica, comprises 91 m of limestones and subsidiary mudstones. The biostratigraphic distribution of rudist bivalves and corals demonstrates that the succession of biostratigraphic markers is consistent with the previously documented standard Guinea Corn Formation succession in the Rio Minho between Grantham and Guinea Corn, central Jamaica. Additionally, the Slippery Rock River succession shows the boundary between the *Chiapasella radiolitiformis* and *C. trechmanni* zones that has not previously been documented. The marker horizons are also consistent with major facies changes within both sections, demonstrating that both lithological changes and biostratigraphic markers are synchronous within the limestone successions of central Jamaica. This may prove to be a valuable tool for stratigraphic correlation elsewhere in Jamaica and within the Antillean region.

Keywords: Rudist bivalves; Corals; Biostratigraphy; Jamaica; Upper Cretaceous; Guinea Corn Limestone

1. Introduction

Sections of the Guinea Corn Limestone of central Jamaica are critical to understanding the extinction patterns of late Maastrichtian rudists: they have a highly diverse and abundant fauna (Chubb, 1971; Mitchell, 1999, 2002; Mitchell and Gunter, 2002), and the age of the rocks has been well constrained by strontium isotopic dating (Steuber et al., 2002).

Previous work has concentrated on the well-exposed sections in the Rio Minho ("standard Guinea Corn succession") between Grantham and Frankfield in the Central Inlier (Fig. 1), where a detailed bed succession has been worked out (Mitchell, 1999, 2002; Mitchell and Gunter, 2002). Mitchell (1999) divided the succession into beds labelled A–G based on variations in clastic:carbonate ratios. He also recognized a number of prominent rudist marker bands. Although traditionally placed within a *Titanosarcolites* zone (e.g., Chubb, 1971), Mitchell and Gunter (2002) erected two zones in these limestones based on successive species of the rudist genus *Chiapasella*. Unfortunately, in the Rio Minho sections, the interval between these two zones falls within a faulted gap between the Middle C and Upper C Beds. To understand the succession of rudists and other fossils, it is critical to document a section that contains the boundary between the two zones.

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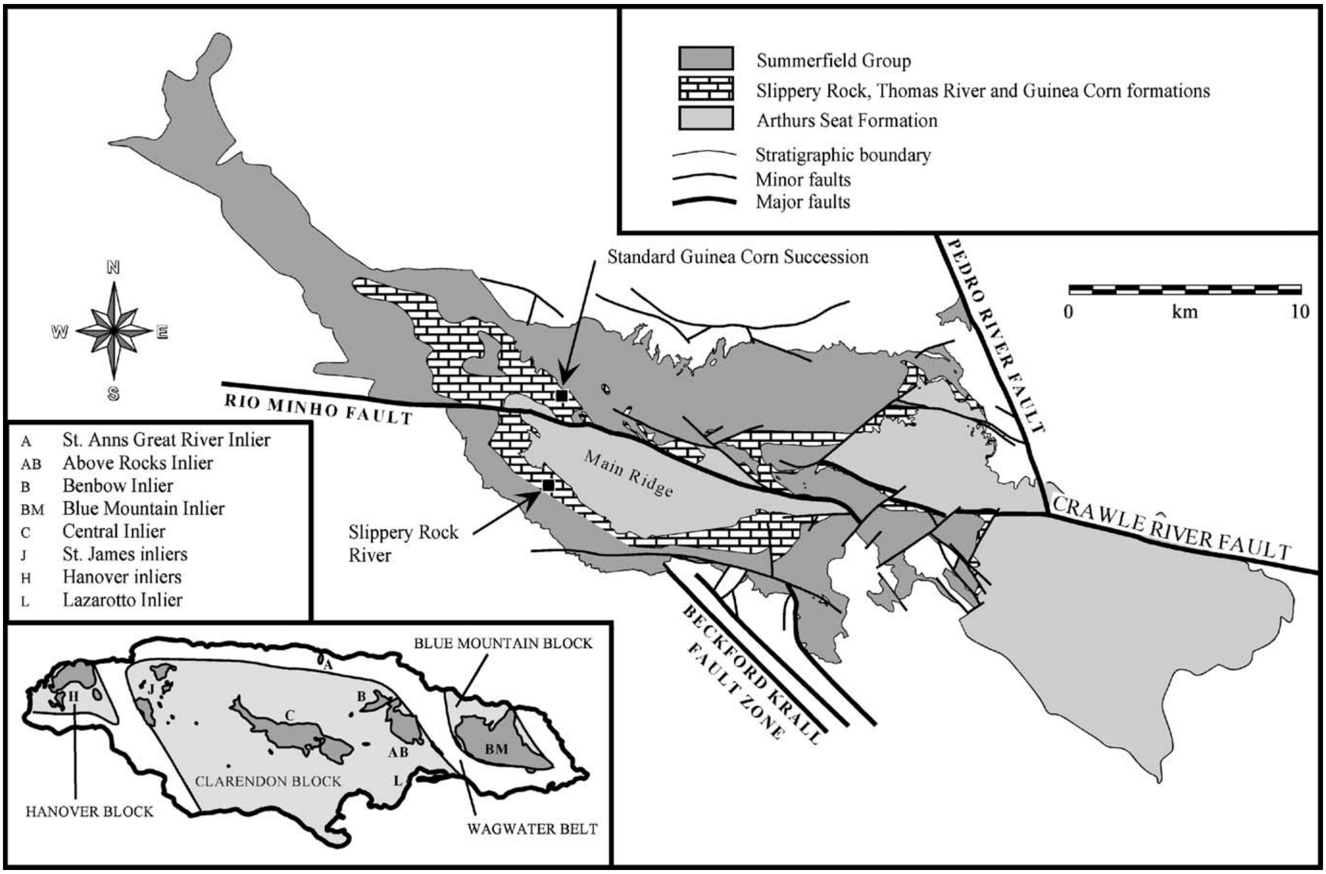


Fig. 1. Distribution of the Slippery Rock River and standard Guinea Corn successions in the Central Inlier, Jamaica. Inset: distribution of Cretaceous inliers (dark grey) and general structural setting of Jamaica (with major tectonic blocks: light grey).

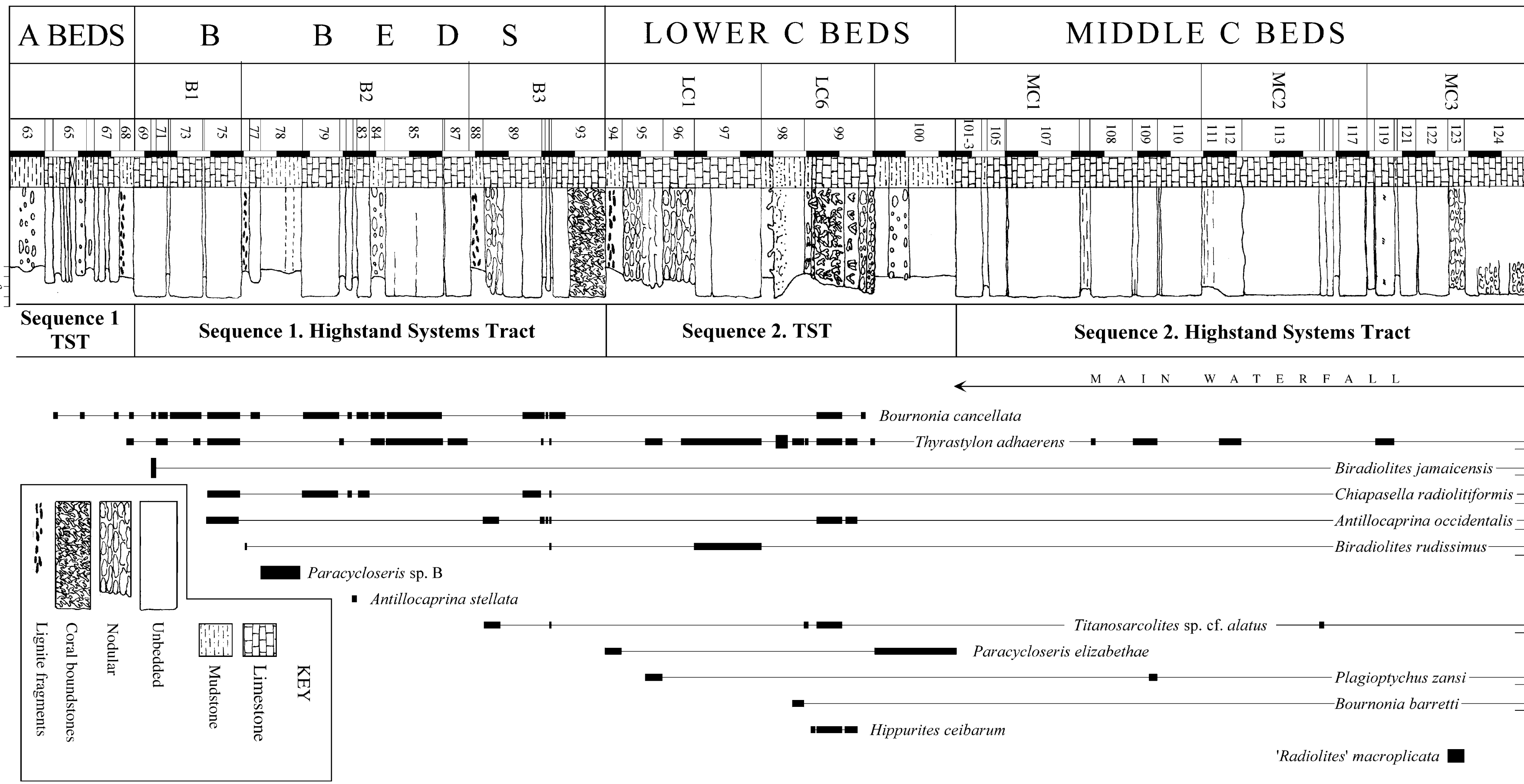
To date, relatively few other sections through the Guinea Corn Formation have been described. Coates (1965) described a section in Pindars River, whereas a section measured by M.T. Kozary in the Slippery Rock River was published by Meyerhoff and Kreig (1977) and Robinson (1988). Coates' section is relatively thin and dominated by volcaniclastic sedimentary rocks, and the thin limestones yield only *Chiapasella radiolitiformis* (Trechmann), indicating the lower of Mitchell and Gunter's (2002) *Chiapasella* zones. The Slippery Rock River section published by Meyerhoff and Kreig (1977) indicated a thickness of about 30 m for the Guinea Corn Formation that is underlain by conglomerates of the Slippery Rock Formation and overlain by the Summerfield Formation (sensu Coates, 1968 = Summerfield Group of Mitchell and Blissett, 2001). Provisional observations by two of us (SFM and IB) indicated that the lower part of this section contained *C. radiolitiformis*, whereas the upper part yielded *C. trechmanni*. Consequently, this section is extremely important for understanding the relationships of the two *Chiapasella* zones.

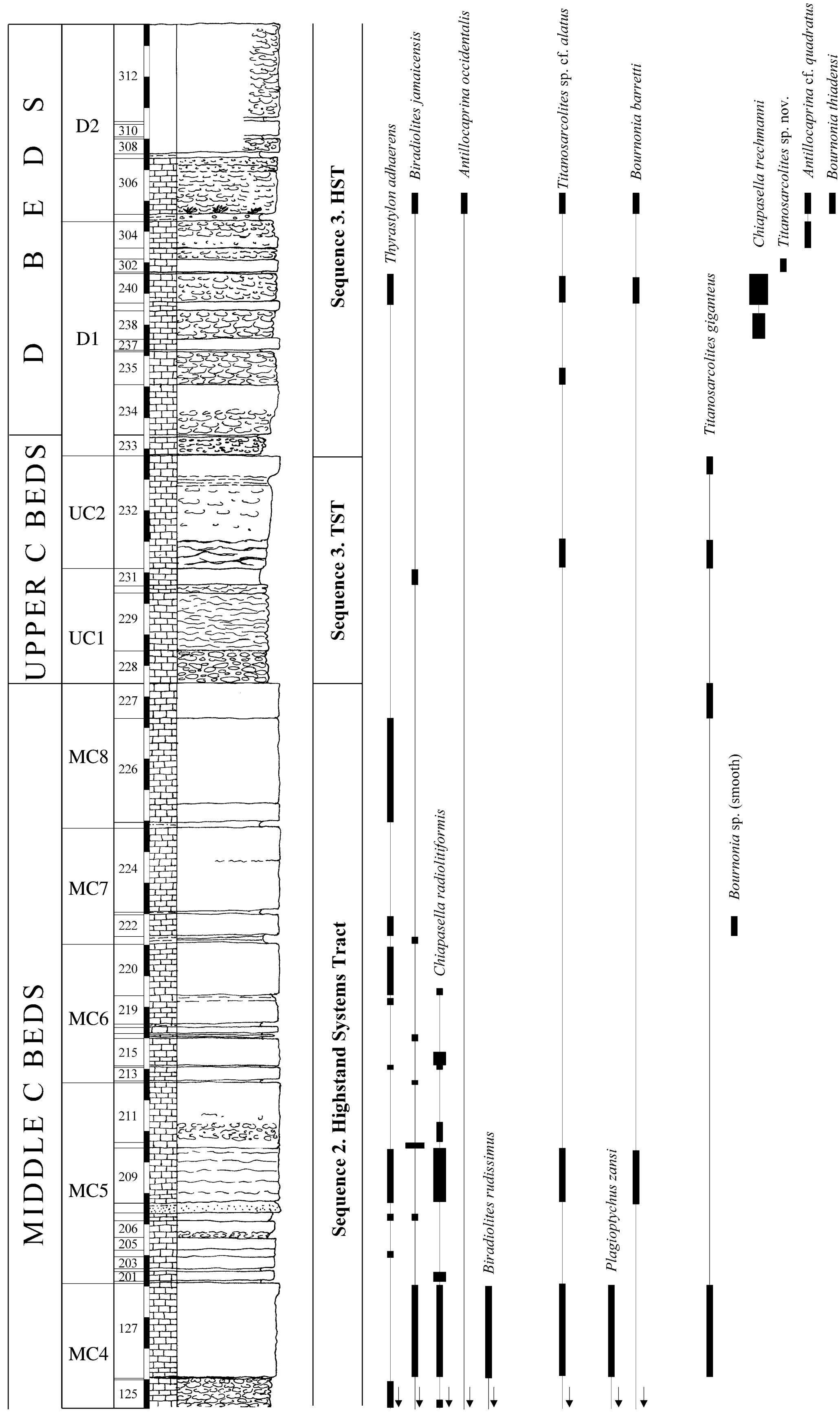
Here, we describe the detailed lithostratigraphy of the succession, together with the succession of rudists and corals. Representative samples of the rudists and corals have been collected and deposited in the University of the West Indies Geology Museum (UWIGM numbers).

2. Lithological succession

The section is exposed in the Slippery Rock River (Fig. 1), some 150 m south of the new road bridge. The beds dip gently to the south, and the section is exposed for about 400 m along the river course. It is divided in two by a prominent thick limestone that forms a waterfall 15 m high. Bed numbers are those used for logging the succession. The section was logged on three separate occasions: beds 63–101 by SFM and DB in 1997; beds 101–127 by SFM in 2003; and beds 200–240 and 301–312 by SFM and IB in 2001. Two numbering systems have been used for the top of the succession because these parts of the section are on different sides of

Fig. 2. Graphic log, probable systems tracts, and distribution of rudists and selected corals in the lower part of the Slippery Rock River section (in metres). Horizontal scale for clastic sediments is grain size (c, clay; s, silt; f, m & c, fine, medium and coarse sand). Horizontal scale for limestones represents the weathering profile. Arrows indicate that species range extends beyond the section.


A BEDS
B BEDS
LOWER C BEDS
MIDDLE C BEDS
B1
B2
B3
LC1
LC6
MC1
MC2
MC3
63
65
67
68
69
71
73
75
77
78
79
83
84
85
87
88
89
93
94
95
96
97
98
99
100
101-3
105
107
108
109
110
111
112
113
117
119
121
122
123
124
c s f m c
Sequence 1 TST
Sequence 1. Highstand Systems Tract
Sequence 2. TST
Sequence 2. Highstand Systems Tract
MAIN WATERFALL
Bournonia cancellata
Thyrastylon adhaerens
Biradiolites jamaicensis
Chiapasella radiolitiformis
Antillocaprina occidentalis
Biradiolites rudissimus
Paracycloseris sp. B
Antillocaprina stellata
Titanosarcolites sp. cf. alatus
Paracycloseris elizabethae
Plagioptychus zansi
Bournonia barretti
Hippurites ceibarum
'Radiolites' macroplicata
KEY
Limestone
Mudstone
Unbedded
Nodular
Coral boundstones
Lignite fragments


MIDDLE C BEDS
UPPER C BEDS
D BEDS
MC4
MC5
MC6
MC7
MC8
UC1
UC2
D1
D2
125
127
201
203
205
206
209
211
213
215
219
220
222
224
226
227
228
229
231
232
233
234
235
237
238
240
302
304
306
308
310
312
Sequence 2. Highstand Systems Tract
Sequence 3. TST
Sequence 3. HST
Thyrastylon adhaerens
Biradiolites jamaicensis
Chiapasella radiolitiformis
Antillocaprina occidentalis
Biradiolites rudissimus
Titanosarcolites sp. cf. alatus
Plagioptychus zansi
Bournonia barretti
Titanosarcolites giganteus
Bournonia sp. (smooth)
Chiapasella trechmanni
Titanosarcolites sp. nov.
Antillocaprina cf. quadratus
Bournonia thiadensi

the river (the correlation between them is based on lithological similarities and similar fossil occurrences). The Guinea Corn Formation rests on mudstones with subsidiary ripple-cross-laminated sandstones of the Thomas River Formation of Mitchell and Blissett (2001) (not conglomerates as suggested by Meyerhoff and Kreig, 1977). It is overlain by interbedded sandstones and mudstones of the Green River Formation (of Mitchell and Blissett, 2001) of the Summerfield Group, although the contact with the latter is not exposed and there may be minor faulting.

Beds 63–68 are exposed at the base of the succession. The lowermost bed, 63, consists of mudstones. It contains a relatively diverse ostracod fauna. Overlying beds 64–68 consist of weakly cemented, highly silty limestones, and lignite-rich mudstones (Fig. 2).

Bed 69 marks a major facies change with the appearance of strongly cemented limestones with abundant, relatively diverse rudist assemblages, and thin intervening mudstone horizons. Four major limestone divisions (beds 69–75, 79–87, 89–93 and 95–97) are present, separated by thin lignite-rich mudstones (Fig. 2). Beds 98–100 are mudstone dominated; bed 98 contains a distinctive omission surface, which is overlain by sandy mudstones that are piped downwards into *Thalassinoides* burrows. Bed 100 is the thickest mudstone unit in the section (Fig. 2).

Bed 101 marks the most obvious facies change in the whole section. It represents the appearance of prominent limestones with only very thin silty mudstone layers between (Figs. 2, 3). This part of the section forms a small gorge and the main waterfall. The remainder of the section consists of massive and nodular limestones. Beds 228–233 contain more siltstone, largely in flaser marls, whereas beds 234–312 are more strongly nodular.

It is likely that the differences in lithology relate to depositional sequences. Three of these are recognized (Figs. 2, 3). The A, LC and UC beds are attributed to transgressive systems tracts, and the B, MC and D beds to highstand systems tracts. A full discussion of the sequence stratigraphy is beyond the scope of this paper.

3. Faunal succession

3.1. Rudists

Rudists are the most prominent faunal elements present in the Guinea Corn Formation at Slippery Rock River. The rudist taxonomy used here is based on Chubb (1971), but with amendments on various groups, as given by Mitchell and Gunter (2002) and Mitchell (2003). Representative rudists are shown in Fig. 4, and their distribution is shown in Figs. 2 and 3.

Beds 65–67 contain a low diversity assemblage of rudists with common, poorly preserved examples of *Bournonia cancellata* (Whitfield) and rare *Thyrastylon adhaerens* (Whitfield).

Beds 69–89 contain a much more diverse assemblage of rudists, with abundant examples of *Bo. cancellata* and *Th. adhaerens*, together with common *Antillocaprina occidentalis* (Whitfield), *Chiapasella radiolitiformis*, *Biradiolites jamaicensis* Trechmann (in one bed) and *Bi. rudissimus* Trechmann. Sporadic examples of *Titanosarcolites* sp. cf. *alatus* Chubb, *Antillocaprina stellata* Chubb and *Plagioptychus zansi* Chubb also occur.

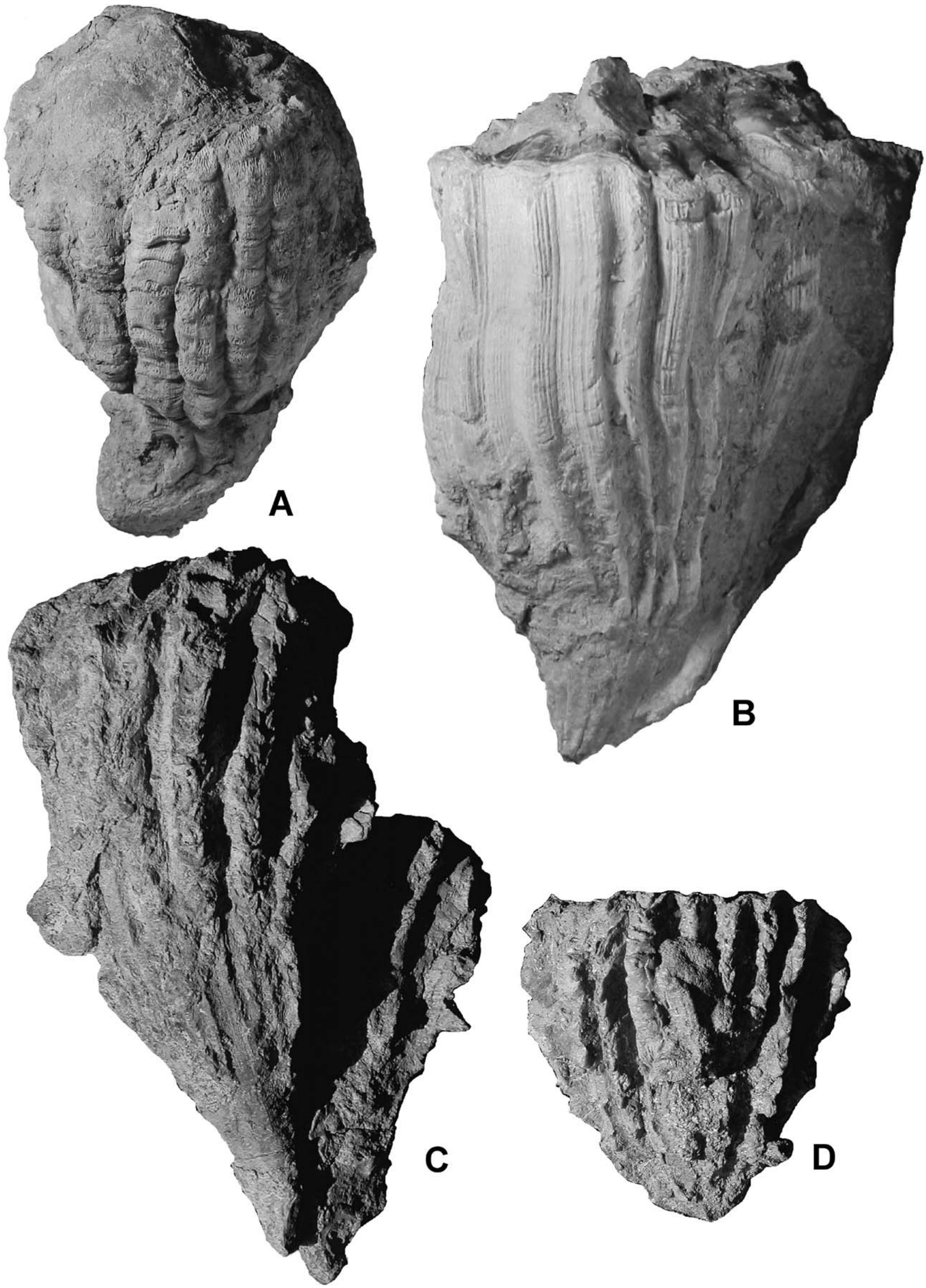
Beds 94–100 contain a lower diversity and abundance of rudists. *Th. adhaerens* is fairly common, and scattered examples of *Bo. cancellata*, *Bo. barretti* Trechmann, *Bi. rudissimus* and *Ti.* sp. cf. *alatus* also occur. Of particular note is the common occurrence of clusters of *Hippurites ceibarum* Chubb that had grown among abundant ramose and small massive corals in bed 99 (Mitchell, 2002).

Beds 101–124 contain a low diversity assemblage of small radiolitids (mainly *Th. adhaerens*). Specific records are shown in Fig. 2, but unidentified small radiolitids occur throughout. Bed 123 yields abundant "*Radiolites*" *macroplicata* Whitfield. Beds 125–210 have rich assemblages of rudists with abundant *C. radiolitiformis*, *Th. adhaerens*, *Bi. jamaicensis*, *Bi. rudissimus*, *Titanosarcolites giganteus* (Whitfield), *Bo. barretti* and *Ti.* sp. cf. *alatus*. Beds 211–227 yield lower diversity faunas with *Th. adhaerens* and *Bi. jamaicensis* being the only two species recorded. *C. radiolitiformis* is common in the lower part, but does not extend above the basal portion of bed 220.

Beds 228–237 also have low diversity faunas, although this does not seem to be an artefact of hard limestones because of the lack of larger radiolitids. *Ti. giganteus* is sporadic, and *Bi. jamaicensis* and *Ti.* sp. cf. *alatus* are also present. Diversity and abundance increase above this. Beds 237–306 contain abundant *C. trechmanni*, *Antillocaprina* cf. *quadratus* (Whitfield) and *Titanosarcolites* sp., together with scattered *Ti.* sp. cf. *alatus*, *Th. adhaerens* and *Bo. barretti*. Unfortunately, the uppermost part of the section is inaccessible.

The rudist distribution patterns show some general relations to lithology (Figs. 2, 3). The smaller, elevator rudists belonging to the genera *Bournonia* and *Biradiolites* occur in both the transgressive and highstand systems tracts. The large, recumbent *Ti. giganteus* and

Fig. 3. Graphic log, probable systems tracts and distribution of rudists and selected corals in the upper part of the Slippery Rock River section (in metres). Horizontal scale for clastic sediments is grain size (c, clay; s, silt; f, m & c, fine, medium and coarse sand). Horizontal scale for limestones represents the weathering profile. Arrows indicate that species range extends beyond the section.


A
B
C
D

the elevator *Chiapasella* occur in the purer carbonates of the highstand systems tracts (B and MC beds), although *Ti. giganteus* also occurs in the transgressive systems tract (UC beds).

3.2. Corals

Corals are common at many levels within the Guinea Corn Formation, but there has been only limited recent work on this aspect of the fauna (e.g., Coates, 1977; Baron-Szabo, 2002; Mitchell, 2002; Stemann et al., in press). Most of the taxonomic work still resides in papers from the late nineteenth and early twentieth centuries (e.g., Duncan and Wall, 1865; Vaughan, 1899; Wells, 1934, 1935).

Paracycloseris sp. nov. B (a distinctive, turbinate solitary coral lacking an epitheca) occurs in bed 78 (Fig. 2), whereas bed 88 contains *Dichocoenia trechmanni* Wells, *Diplaraea boltonae* Wells, and *Goniopora trechmanni* Wells, bed 92 contains *G. reussiana* Duncan and bed 93 *Actinacis* sp. Beds 94 and 100 contain *Paracycloseris elizabethae* Wells (Fig. 2). Beds 95 and 96 contain common *Actinacis* spp. The richest coral assemblage occurs in bed 99 with ramose *Actinacis* spp. and *Multicolumnastrea cyathiformis*; phaceloid *Calamophyllia quaylei* (Wells), *Calamophylliopsis* sp., *Nefophyllia* sp., and *Placosmilia* sp.; as well as encrusting-massive colonies of *Centrastrea hilli* Vaughan, *Dichocoenia trechmanni*, *G. trechmanni*, *Leptoria conferticostata* (Vaughan), *Mesomorpha catadupensis* Wells, *Microsolena* sp., *Montastraea schindewolfi* (Wells), *Ovalastrea anomalos* (Wells) and *Synastrea* sp. The solitary corals *Haplarea* sp., *Pa. elizabethae* and *Trochoseris catadupensis* Vaughan are also found in bed 99.

Scattered corals occur towards the top of the section. Bed 231 contains *Dichocoenia trechmanni*, *Mu. cyathiformis* and *Synastrea* sp., whereas bed 232 contains *D. trechmanni*, *G. reussiana*, *Me. catadupensis* and *Mo. schindewolfi*. Bed 238 contains *Actinacis* sp., *G. reussiana*, *Microsolena* sp. and *Mu. cyathiformis*, whereas bed 302 contains *Actinacis* sp., *D. trechmanni*, *Me. catadupensis* and *Mu. cyathiformis*. Near the top of the exposed section, bed 306 contains the phaceloid coral *Nefophyllia* sp.

The coral assemblages also show relationships with the lithology. The corals found in the siltstone lithologies belong to the *Paracycloseris*–?*Damosmilia* assemblage of Mitchell (2002). This was interpreted to live on soft substrates and to have been tolerant of raised nutrient fluxes. The coral assemblages in other parts of the section are similar or identical to the *Actinacis*–*Multicolmnatrea* and *Actinacis*–*Ovalastrea* assemblages of Mitchell (2002). The corals are embedded in a clastic siltstone or micritic mudstone matrix and were probably tolerant of moderate sediment influx (Mitchell, 2002).

4. Correlation

The Guinea Corn Formation exposed in the Slippery Rock River can be correlated with the standard Guinea Corn succession using rudist assemblages, zones and marker beds together with the distribution of the corals *Paracycloseris* sp. B and *Pa. elizabethae*. When the marker beds between the two sections are correlated, there is also a strong correlation of vertical facies changes: this allows the standard succession divisions established by Mitchell (1999) to be used in the Slippery Rock River section (Figs. 2, 3, 5).

The A Beds contain low diversity rudist assemblages in silty limestones. The B Beds are represented by three prominent limestone divisions that yield a diverse rudist assemblage including *C. radiolitiformis*. The last appearance of *Paracycloseris* sp. B in lower B2 links closely with the last appearance of this species in the B beds of the type Guinea Corn Formation.

The Lower C Beds are characterized by thicker mudstones, and thinner silty limestones with lower diversity rudist faunas or fairly frequent coral beds. Of particular significance is the common occurrence of the solitary coral *Pa. elizabethae*, a marker for the Lower C Beds in the standard Guinea Corn succession.

The Middle C Beds begin with a major facies change to thick limestones with only thin silty layers. Similar rudist assemblages are present in the standard and Slippery Rock River sections. MC3 yields "*R.*" *macroplicata*, whereas MC4–MC6 yield abundant *C. radiolitiformis*. The top of the Middle C Beds are not exposed in the standard Guinea Corn succession.

The Upper C Beds yield very low diversity rudist faunas and are relatively thin. However, only the top of these beds has been seen in the standard succession.

The D Beds are represented by nodular limestones and contain an abundance of *C. trechmanni* in their lower part. This is directly analogous to the D Beds in the standard succession, where *C. trechmanni* has its peak abundance in upper D1 (Mitchell and Gunter, 2002).

Table 1 compares the thicknesses of the various divisions between Slippery Rock River and the standard Guinea Corn succession. The notable difference in thickness is in Lower C Beds. The Lower C Beds at Slippery Rock River contain an important omission

Fig. 4. Representative rudists from the Guinea Corn Formation. A, *Chiapasella radiolitiformis* (Trechmann), UWIGM, RUD.2000.53, Middle C Beds, Union section; ×0.5. B, *Chiapasella trechmanni* Mitchell and Gunter, holotype, UWIGM.RUD.2000.69, specimen in a cluster of three; ×0.7. C, *Bournonia cancellata* (Whitfield), UWIGM.RUD.2002.89, upper A Beds, standard Guinea Corn succession; ×1. D, *Bournonia barretti* Trechmann, UWIGM.RUD.2002.90, Lower C Beds (bed 98), Slippery Rock River; ×1.

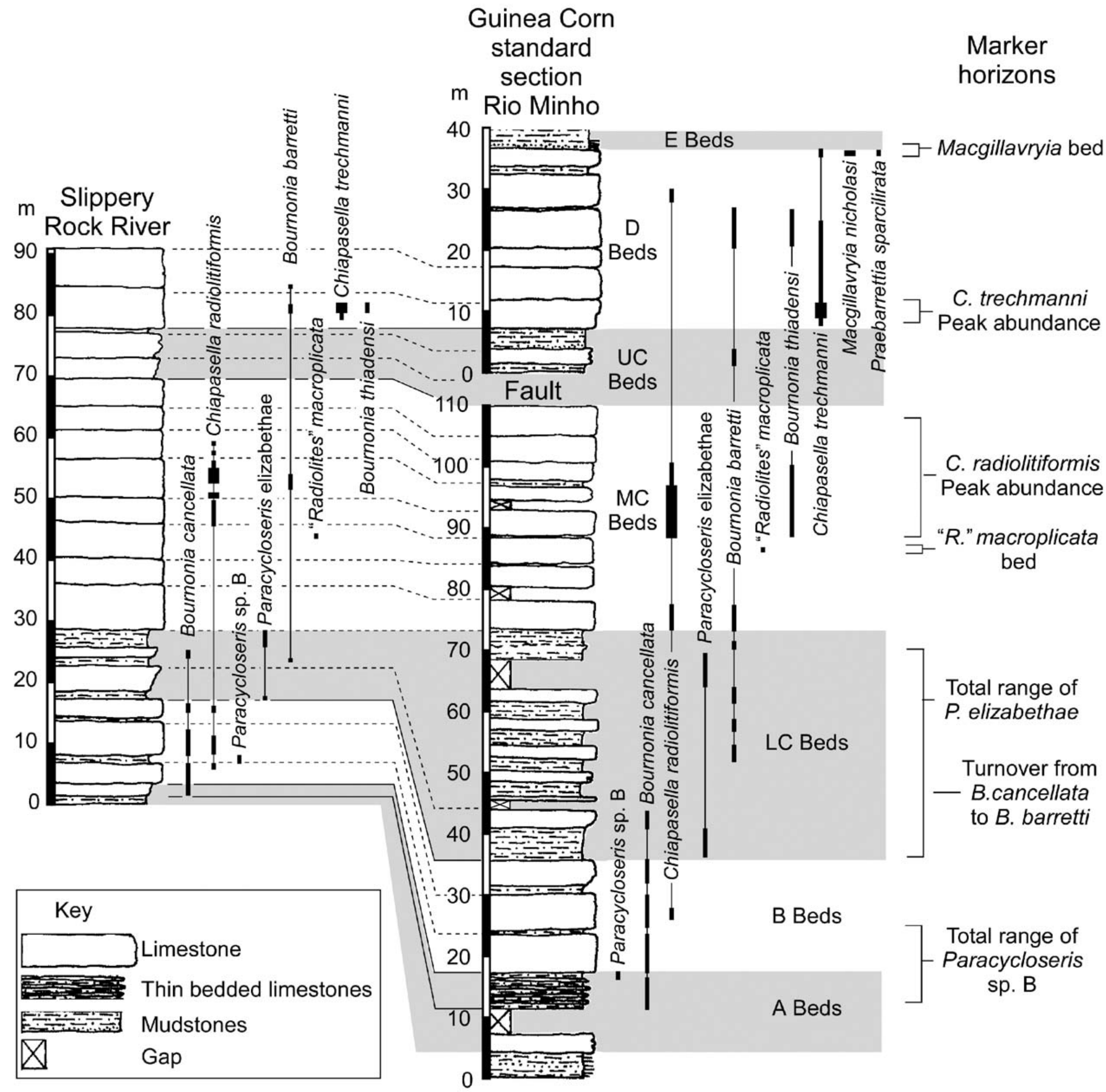


Fig. 5. Correlation of sections in the Guinea Corn Formation between Slippery Rock River and the standard sections in the Rio Minho using marker horizons. The main lithological changes (A, B, LC, MC, UC and D beds) also correlate, although an erosion surface at Slippery Rock River has cut out the middle LC Beds.

(erosion) surface that may have removed some of the section.

5. Discussion

A continuous section through the lower part of the Guinea Corn Formation, situated some 5 km south of the type section, has been described. [A suggested left lateral strike slip displacement of 10 km along the Rio Minho–Crawle River Fault zone (Mitchell, in press) would give a distance of some 12 km between the sections.]

The succession of rudist assemblages in the Slippery Rock River section is similar to that seen in the standard Guinea Corn succession. In addition, the two *Chiapasella* zones of Mitchell and Gunter (2002), as well as rudist marker beds, can be correlated between the two sections. The distribution of the small corals *Paracycloceris* sp. nov. B and *Pa. elizabethae* is also consistent. Using these biostratigraphic criteria, the major facies changes, which Mitchell (1999) used to divide the standard succession into divisions, can be recognized in the Slippery Rock River section. This suggests that the biostratigraphic markers recognized here are consistent between nearby sections on a scale of kilometres. The extension of this

Table 1
Thickness of divisions in the Guinea Corn Formation

Division	Standard Rio Minho Section (Guinea Corn)	Slippery Rock River
A Beds	12.8 m	3.7 m*
B Beds	18.9 m	14.3 m
Lower C Beds	36 m*	10.5 m
Middle C Beds	38 m	41 m
Upper C Beds	7 m*	8 m
D Beds	29 m	13 m*

* indicates incomplete owing to non-exposure or faulting; thicknesses for Rio Minho based on Mitchell (1999) and Mitchell and Gunter (2002).

marker system elsewhere in Jamaica, and the Caribbean region, should be explored. The consistency of facies changes that can be correlated using the marker bands suggests that these may be of basin-wide importance. Such facies changes might be related to external forcing (eustatic sea-level changes) or to local volcanic arc-related forcing (e.g., episodic volcanic episodes). If of widespread significance, such facies changes related to a regional biostratigraphic scheme might lead to a detailed correlation of late Maastrichtian sedimentary successions in the Caribbean.

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