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The nautiloid *Aturia* (Mollusca, Cephalopoda) in the Mid-Cainozoic of Jamaica and Carriacou

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Recent collections in Jamaica and Carriacou have yielded new specimens of the nautiloid *Aturia*, a rare fossil in the Antilles. Hitherto, many of these specimens have not been described or illustrated and those derived from the Middle Miocene Grand Bay Formation of Carriacou represent the youngest nautiloids now known from the Caribbean. Additionally, stratigraphic nomenclature provided for some previously reported Jamaica and Carriacou *Aturia* is herein revised to better place these very uncommon fossils in their proper lithostratigraphic context.

KEY WORDS: *Aturia*, Cephalopoda, Jamaica, Carriacou, Eocene, Miocene.

Introduction

Nautiloids are rare fossils in the Cainozoic of the Americas, including the Caribbean. Nautiloids occur from the Paleocene to Miocene of the Antillean region, but are unknown from younger deposits (Schmidt & Jung, 1993, table 1), a pattern that reflects the global decline of this group at that time (Miller, 1947, 1949; Kummel, 1964, fig. 280). Teichert (1986, p. 234) noted that, '... no remains of nautiloids had ever been reliably reported from rocks of Pliocene or Pleistocene age anywhere in the world.' Indeed, apart from rare loliginid statoliths (Clarke & Fitch, 1975, 1979), fossil cephalopods are unknown from the Plio-Pleistocene of the Antillean region.

Caribbean nautiloids attributable to the genus *Aturia* Bronn, 1838, have been reported from the Eocene of Colombia, Jamaica, Panama and Venezuela, the Oligocene of Cuba and Puerto Rico, and the Miocene of Carriacou, Cuba, Jamaica, Martinique, Trinidad and Venezuela (Miller, 1947; Jung, 1971; Schmidt & Jung, 1993; Donovan *et al.*, 1995). Four nominal species of *Aturia* have been reported from the Caribbean; *A. peruviana* Olsson, 1928, *A. panamensis* Miller, 1947, *A. cubaensis* (Lea, 1841), and *A. curvilineata* Miller & Thompson, 1937. However, the systematic position of these conchs is very problematic below the generic level. For example, Miller (1947, p. 92) considered that the holotype of Miocene? *A. cubaensis* did not differ greatly from similar-sized *A. alabamensis*, commonly found in the Eocene of the southeastern United States. He also suggested that the Eocene *A. panamensis* and *A. peruviana* might be conspecific, and noted the close similarity of both species to typical representatives of *A. alabamensis*. Jung (1966) placed the Miocene *A. curvilineata* in synonymy with the Miocene *A. cubaensis*. Clearly, specific placement of *Aturia* fossils is problematic, with their indifferent preservation, and nominal species being based on juveniles or the remnants of more mature individuals (Furnish & Glenister, 1987; Chirat, 2000; R.A. Hewitt, written comm.). Our new material from the Lower Miocene Montpelier Formation (White Limestone Group) of Jamaica, and the Middle Miocene Grand Bay Formation of Carriacou are similarly difficult to include in nominal species with confidence. Chirat (2000) made an elegant argument that the global diversity of *Aturia* may be inflated due to geographically separated and indifferently preserved specimens being given different names, when they represented widely drifted shells of but a few species (in contrast, taphonomic evidence from shells at some localities suggests they are local mortalities of juveniles; R.A. Hewitt, written comm.). This formed part of Chirat's argument for the necessity of a thorough taxonomic revision of the genus. In consequence, we consider it conservative to place all of our specimens from Jamaica and Carriacou in open nomenclature as

Specimen	Locality	Formation
Aturia sp. A*		
NMB J 31311	NMB 10897	Troy Formation
Aturia sp. B+		
UF 38813	UF XJ015	Montpelier Formation
UF 68422	UF XJ015	Montpelier Formation
UF 68427	UF XJ015	Montpelier Formation
UF 68436	UF XJ015	Montpelier Formation
UF 107841	UF XJ015	Montpelier Formation

Table 1. *Aturia* sp. from the White Limestone Group of Jamaica. Key: * = see Schmidt & Jung (1993, text-fig. 1) for locality map (although originally reported as Claremont Formation (Jung, 1971), this outcrop is now part the Troy Formation (Mitchell, 2004)), + = see Donovan (1995, fig. 1.2) for locality map.

Specimen	NMB Locality	Formation
Aturia sp. C		
NMB J 32964	10793, north of Kendeace Pt.	Kendeace Formation
NMB J 32965	13759, west of Kendeace Pt.	Kendeace Formation
NMB J 32966	13759, west of Kendeace Pt.	Kendeace Formation
Aturia sp. D		
UF 108574	10730, Point St. Hilaire	Grand Bay Formation (tuffaceous facies)
UF 108575	10707, north of Tarleton Pt.	Grand Bay Formation (tuffaceous facies)
UF 112028	10707, north of Tarleton Pt.	Grand Bay Formation (tuffaceous facies)
UF 112029	10708, Tarleton Point	Grand Bay Formation (tuffaceous facies)
UF 112030	10723, north of Tarleton Pt.	Grand Bay Formation (sandy facies)
UF 104796	10804, north of Pt. Saint Hilaire#	Basal Grand Bay Formation

Table 2. *Aturia* sp. from the Miocene of Carriacou, The Grenadines. See Jung (1971, text-fig. 1) for locality map. Key: # = this locality was considered by Jung (1971) to be Kendace Calcareous Silt Member, but it is now considered to be the basal member of the Grand Bay Formation (Donovan *et al.*, 2003).

Aturia sp. A to D, while recognising that some of our species may subsequently be shown to be synonymous if superior specimens become available.

All specimens discussed herein are reposited in the Naturhistorisches Museum, Basel (NMB) or the Florida Museum of Natural History, University of Florida, Gainesville (UF). Our philosophy of open nomenclature follows Bengtson (1988).

Jamaica

The White Limestone Group of Jamaica, a unit exposed over more than half the island, has been studied and debated by numerous researchers for over 175 years (see, for example, De la Beche, 1827; Sawkins, 1869; Hill, 1899; Trechmann, 1922; Hose & Versey, 1957; Versey, 1957; Zans *et al.*, 1963; Wright, 1974; Robinson, 1994). Mitchell (2004) provided a revised lithostratigraphic scheme for the White Limestone Group that we follow herein.

De la Beche (1827, p. 170) provided the earliest record of a nautiloid, *Nautilus*, from his white limestone formation (see also Miller, 1947, p. 10). It is considered most probable that this specimen was collected from what is now the mid Lower to mid Middle Eocene Yellow Limestone Group, in which nautiloids are more diverse (Schmidt & Jung, 1993; Donovan *et al.*, 1995; Donovan & Draper, 2001). Jung (1972, table 1) and Schmidt & Jung (1993, pp. 349, 351, fig. 4.4) recorded only a single fragmentary specimen of *Aturia* sp. from the Eocene Claremont Formation (= Troy Formation *sensu* Mitchell, 2004) and none are reported from the Jamaican Oligocene. The youngest Caribbean nautiloids are Miocene and in Jamaica are locally common in the Lower Miocene Montpelier Formation (Schmidt & Jung, 1993, p. 349; Donovan *et al.*, 1995, p. 589, figs 1.2-1.4). Specimens only occur in deep-water deposits on slide blocks derived from shallow-water reefs, exposed at the large, disused chalk quarry near Duncans, parish of Trelawny.

Carriacou

The Miocene sedimentary geology of Carriacou was described in detail by Robinson & Jung (1972), Speed *et al.* (1993) and Donovan *et al.* (2003); two of the four Miocene formations have yielded *Aturia.*

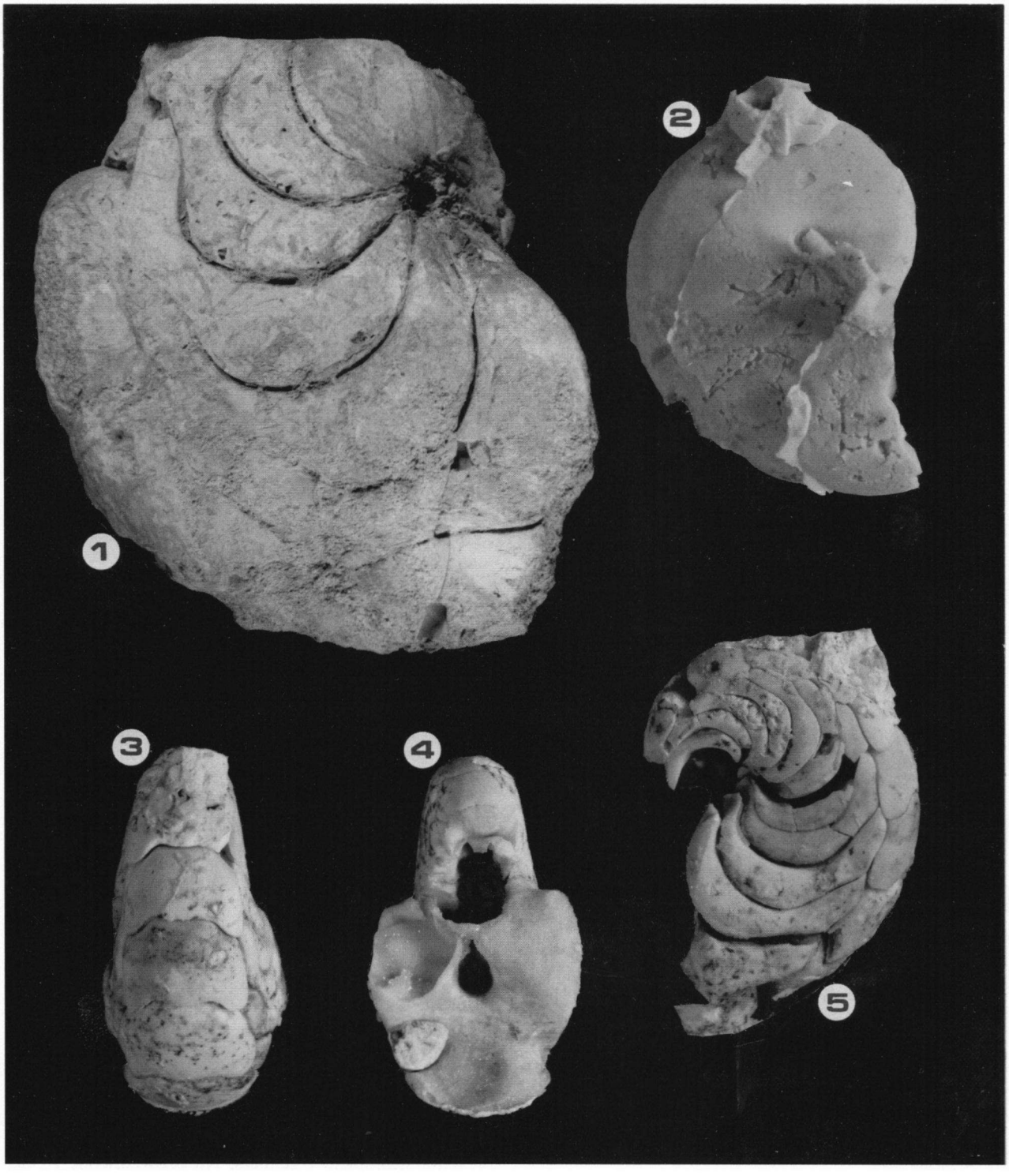

Figure 1. *Aturia* spp. from the White Limestone Group, Jamaica.

1 - *Aturia* sp. A, NMB J 31311 (Middle Eocene Troy Formation), right lateral view of incomplete phragmocone (internal mould), x 1.

2-5 - *Aturia* sp. B, UF 107841 (Lower Miocene Montpelier Formation), right lateral view (2) of RTV silicone rubber peel taken from incomplete external mould of phragmocone; posterior view (3) of internal mould; apertural view (4) of internal mould; left lateral view (5) of internal mould. All x 1.5.

All specimens photographed uncoated. The recommendation of Stridsberg (1990), to illustrate cephalopod shells in their presumed life position, has been followed herein.

The Kendeace Formation rests unconformably on the Lower? Miocene Belmont Formation (Donovan *et al.*, 2002, fig. 3). The Kendeace Formation is conglomeratic in part, with included clasts of igneous origin, but is primarily a siltstone unit containing limestone horizons. This formation is discontinuous above the Belmont Formation (Speed *et al.*, 1993), grading upwards into limestones of the Middle Miocene Carriacou Formation. The Grand Bay Formation is the highest Miocene unit, but is not conformable on the Carriacou Formation (Donovan *et al.*, 2003). The formation consists mainly of volcaniclastic conglomerates, sandstones and siltstones with some horizons rich in macrofossils.

Prior to this report, Jung (1971, table 1) listed *Aturia cubaensis*? from the Lower to Middle Miocene Kendeace Formation. New collections made by the authors on Carriacou in 2000 and 2001 have extended the occurrence of *Aturia* into the Middle Miocene Grand Bay Formation, among the youngest nautiloids known from the region. In the present communication, *Aturia* conchs from both the Kendeace and Grand Bay formations are described and illustrated for the first time (Table 2; Figure 2).

Systematic palaeontology

Order Nautilida L. Agassiz, 1847
Family Aturiidae Hyatt, 1894
Genus *Aturia* Bronn, 1838

Aturia sp. A

Figure 1/1

1972 *Aturia* sp. — Jung, p. 466, tables 1, 2.
1993 *Aturia* sp. — Schmidt & Jung, pp. 349, 351, fig. 4.4.

Material, locality and horizon — One specimen (Table 1), NMB J 31311, from a road cut on the Hermitage Dam Road, Stony Hill, above Kingston, Jamaica (for locality map, see Schmidt & Jung, 1993, fig. 1; NMB locality 10897). Derived from an exposure originally reported to be Claremont Formation (Jung, 1971; Schmidt & Jung, 1993), now considered to be part of the Middle Eocene Troy Formation, White Limestone Group (Mitchell, 2004).

Description — An incomplete internal mould of the right lateral portion of an adult phragmocone with eight chambers and visible umbilicus. Siphuncle not seen. Longest dimension of incomplete specimen is 124.7 mm (142 mm according to Schmidt & Jung, 1993, p. 349).

Remarks — Schmidt & Jung (1993) noted some similarity between NMB J 31311 and Eocene *A. alabamensis* figured in Miller (1947, pl. 58), but, given the incomplete condition of the internal mould, they determined that specific identification was unwarranted. This specimen is also close to *A. panamensis* Miller (R.A. Hewitt, written comm.).

Aturia sp. B

Figure 1/2-5

1993 *Aturia* sp. — Schmidt & Jung, p. 349, table 1.
1995 *Aturia* sp. — Donovan *et al.*, p. 589, figs 1.2-1.4.

Material, locality and horizon — Five specimens (see Table 1), UF 38813 (Donovan *et al.*, 1995, figs 1.2-1.4), 68422, 68427, 68436 and 107841 (Figure 1/2-5). All specimens collected from UF locality XJ015 in large, shallow-water, scleractinian slide blocks at a disused chalk quarry, 5.0 km west of Duncans on the south side of the main A1 north coast road, parish of Trelawny, Jamaica (NGR approximately 887 020, 1:50,000 topographic sheet 3 (metric edition), "Falmouth-Browns Town"; GPS reading 18° 28' 30" N 77° 34' 46" W) (for locality map, see Donovan, 1995, fig. 1.2). Lower Miocene Montpelier Formation, White Limestone Group (Mitchell, 2004).

Description — UF 38813 consists of part and counterpart internal mould fragments of a phragmocone showing anterior view with septa and foramen of siphuncle visible. The specimen is 14.1 mm in diameter and 7.3 mm wide. UF 68442 is broken and disarticulated (14 fragments) and represents up to five infilled chambers. The more complete chambers are hollow. The largest fragment, which is two partial chambers, is 11.5 mm in longest dimension. UF 68427, the second most complete specimen of the five, consists of the internal mould of a phragmocone embedded in limestone. The right lateral side shows 13 sutures; only one chamber is visible ventrally. The specimen is 24.2 mm in diameter and 8.6 mm wide. UF 68436 is the anterior portion of an external mould of a phragmocone. Several *in situ*, infilled chambers are also visible, one of which was extracted during initial preparation. The external mould is 32.9 mm in diameter and 12.3 mm wide. UF 107841, the largest and most complete specimen, consists of an internal mould with an external mould of the right lateral and anterior sides. Eight infilled chambers are complete and there are several incomplete chambers. An RTV silicone rubber peel of the external mould measures 43.2 mm in diameter and 22.6 mm wide.

Remarks — At UF locality XJ015 only internal and external moulds have been collected; no original shell remains and very little, if any, distortion occurs in these cephalopod fossils.

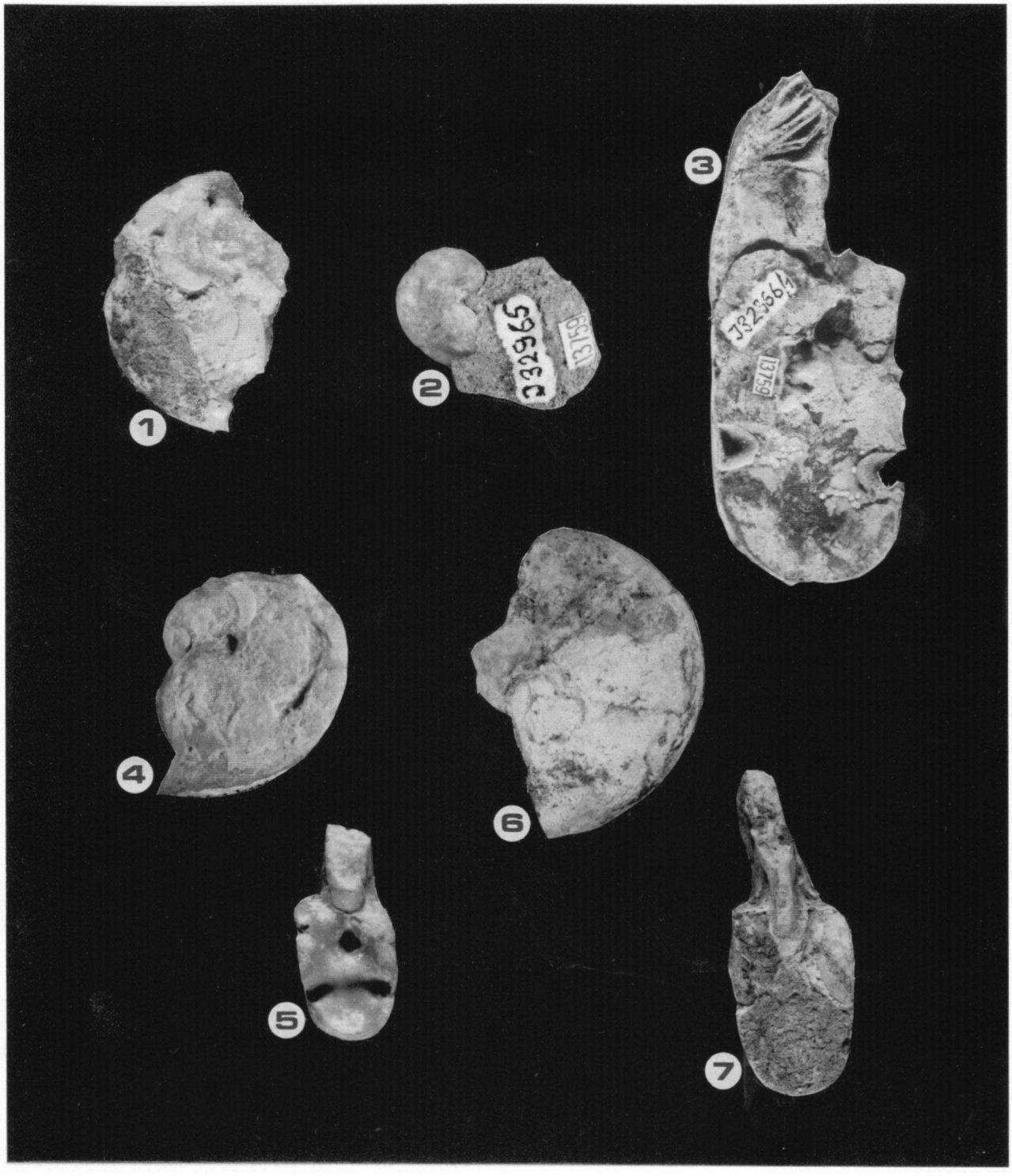

Figure 2. *Aturia* spp. from the Miocene of Carriacou, The Grenadines.

1-3 - *Aturia* sp. C (Lower to Middle Miocene Kendeace Formation), NMB J 32964, right lateral view (1) of recrystallized incomplete phragmocone, x 1.5; NMB J 32965, right lateral view (2) of incomplete phragmocone, x 1.5; NMB J 32966, apertural view (3) of incomplete phragmocone, x 1.

4-7 - *Aturia* sp. D (Middle Miocene Grand Bay Formation), UF 104796, left lateral view (4) of incomplete phragmocone, x 1.5; apertural view (5) of phragmocone, x 1.5; UF 108575, left lateral view (6) of incomplete phragmocone, x 1.0; apertural view (7) of phragmocone, x 1.

All specimens photographed uncoated. The recommendation of Stridsberg (1990), to illustrate cephalopod shells in their presumed life position, has been followed herein.

Nearly all specimens (UF 38813, UF 68422, UF 68436 and UF 107841) exhibit, either partly or fully, a coating of small calcite crystals both on the exterior and hollow interior of the internal moulds (see Donovan *et al.*, 1995, figs 1.2-1.4). Donovan & Portell (2000) reported similar coatings of calcite crystals on echinoids from this locality. Furthermore, the specimen figured herein (UF 107841) is notable for having been infested by borings of clionid sponges, *Entobia* isp. (Blissett & Pickerill, 2004). Donovan & Draper (2001) discussed the significance of sponge borings in Jamaican fossil nautiloids.

***Aturia* sp. C**
Figure 2/1-3

1971 *Aturia cubaensis* (Lea)? — Jung, table 1
1972 *Aturia* — Robinson & Jung, p. 121.

Material and horizon — Three specimens (see Table 2 for locality information); NMB J 32964 (Figure 2/1), J 32965 (Figure 2/2) and J 32966 (Figure 2/3), from the Kendeace Formation of Carriacou (Jung, 1971; Speed *et al.*, 1993). Lower to Middle Miocene.

Description — NMB J 32964 is an incomplete phragmocone with a thin covering of leached shell over about one-third of an internal mould. Nearly five, hollow chambers, infilled with calcite crystals, are visible. The specimen is 30.8 mm in diameter and 11.6 mm at its widest. The smallest (juvenile), but most nearly complete, phragmocone, NMB J 32965, is 13.6 mm in diameter and 9.9 mm wide. It is embedded in matrix and has a thin covering of shell on the right lateral portion of the phragmocone. The left side exposes portions of an internal mould encrusted by calcite crystals. NMB J 32966 is the largest and least complete *Aturia* from the Kendeace Formation. It consists of two chamber fragments that fit tightly together. NMB J 32966 is mostly infilled with muddy sandstone; calcite crystal infilling is minor. A thin shell covers the outside of these fragments. Maximum diameter of these joined fragments is 85.2 mm and maximum width is 34.3 mm.

Remarks — Although Jung (1971, table 1) tentatively placed NMB J 32964 in *Aturia cubaensis*?, this species was subsequently left in open nomenclature by Robinson & Jung (1972).

***Aturia* sp. D**
Figure 2/4-7

Material and horizon — Six specimens (see Table 2 for locality data); UF 104796 (Figure 2/4, 5), 108574, 108575 (Figure 2/6, 7), 112028, 112029 and UF 112030. All from the Grand Bay Formation of Carriacou, Middle Miocene.

Description — UF 104796 is a nearly complete phragmocone, missing only a small portion of dorsal surface. The missing dorsal shell reveals a calcite crystal infilling. A thin aragonite shell covers much of the specimen, but, where absent, septa are revealed; a closed umbilicus is also visible. The diameter is 26.1 mm and maximum width is 11.7 mm. UF 108574 consists of two pieces that make a nearly complete phragmocone (except for a small missing fragment of the posterior and dorsal surfaces). The interior contains mostly sandstone with minor calcite spar. Lateral compaction of the right side is evident. Diameter is 32.1 mm and maximum anterior width is 11.3 mm. UF 108575 is a recrystallized partial phragmocone infilled with sandstone and missing some of its dorsal surface. Like UF 108574, lateral compaction of the phragmocone is evident on the right (lateral) side and is covered by a thin, friable aragonite shell. Diameter is 56.0 mm and maximum anterior width is 20.5 mm. UF 112028 is a large, very poorly preserved phragmocone missing much of its dorsal and lateral surfaces. Visible are the septa and sandstone infilled chambers. The *Aturia* shell is very soft and crumbles easily. Diameter is 57.6 mm and maximum anterior width is 23.0 mm. UF 112029 is a nearly complete phragmocone embedded in matrix with greater than half its left outer shell missing, revealing its septa and chambers infilled by sandstone. The umbilicus is visible on the left side, the right side not having been prepared. Diameter is 31.8 mm, anterior width not measurable. UF 112030 is a phragmocone fragment with its anterior surface exposed in the matrix. Diameter is approximately 35.0 mm, width not measurable.

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