

# Thoughts on the Tobago Crag

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**ABSTRACT.** The so-called Tobago Crag (= Rockly Bay Formation) of C.T. Trechmann is a Pliocene-Pleistocene or Pliocene sedimentary unit exposed on the island of Tobago in the southeastern Antilles on the tropical west coast of the Atlantic Ocean. Crag deposits are typically fossiliferous, Pliocene-Pleistocene and limited to East Anglia. The middle Pliocene Tobago Crag is an exceptional deposit, dominantly composed of barnacles, particularly *Megabalanus tintinnabulum* (Linnaeus). It is not a lenticular deposit, as previously suggested, but is laterally extensive, being littoral to sublittoral in origin and thinning away from the palaeoshoreline, at least in the type area. Sediment was provided by weathering basalt, matrix grain size reducing offshore. In East Anglia, this deposit would undoubtedly have been called a crag.

**Keywords:** Pliocene, East Anglia, Antilles, palaeoecology, balanids, Trechmann.

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## 1. INTRODUCTION

“**CRAG.** A tertiary deposit of the older pliocene period, which has obtained this name from a provincial term signifying gravel. The crag is chiefly developed in the eastern parts of Norfolk and Suffolk, extending thence into Essex; it is seen to rest on the chalk and on the London clay ... By some the crag has been divided into two groups, the lower, or coralline ... and the upper, or red crag ... The fossils of the crag are very numerous ...” (Humble, 1860, pp. 111–112).

“**crag** (1) As a geological term, crag refers to sedimentary rock comprising a shelly, marly sand of marine origin. (2) As a proper noun it is used in East Anglia for certain rock formations of Plio-Pleistocene age ...” (Whittow, 1984, p. 121).

“**Crag.** ... the shelly sandstones of E. Anglia, the main stratigraphical divisions, from below upwards, being the Coralline Crag, Red Crag, and Norwich Crag ... Probably from ‘the Celtic word cregga, meaning a shell, because shells constitute a large part of some of the beds’” (Wyatt, 1986, p. 73).

I started as a new lecturer in the Department of Geology, University of the West Indies, Jamaica, in January 1986. My office, vacated by the previous incumbent, was largely clean and devoid of specimens, apart from some unusually large balanid barnacles which intrigued me. These came, not from Jamaica, but Tobago, almost 2,000 km to the east at the far end of the Caribbean. To cut a long story short, supported in part by a small grant from the Palaeontological Association, I had two short field seasons in south-west Tobago, in the 1980s. Both were happy and constructive

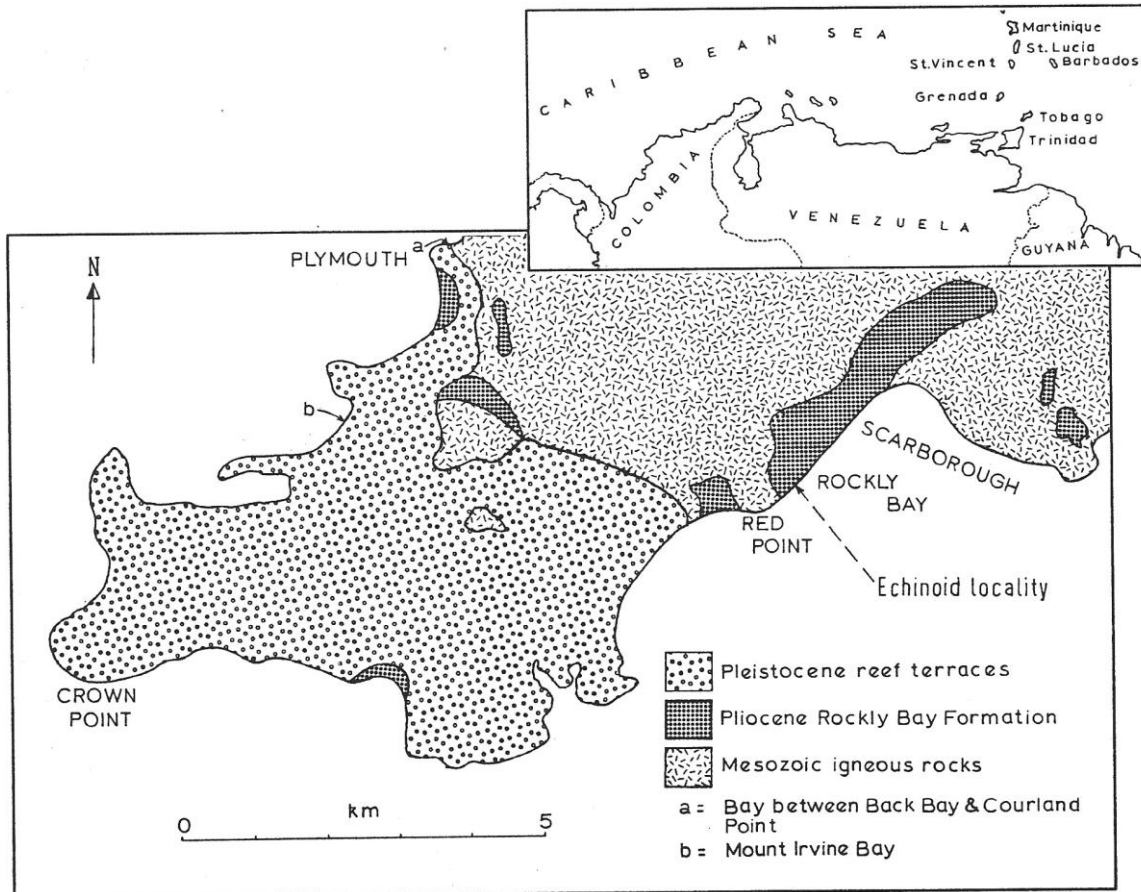
(Donovan, 1989a, b; Jackson and Donovan, 1994).

My focus was on coastal (= type section) and inland exposures of the Rockly Bay Formation, previously referred to as the Tobago Crag by Trechmann (1934). As a dabbler in the palaeontology of the Waltonian Red Crag Formation of Essex since the mid-1970s (e.g., Donovan, 1988, 2025; Donovan and Donovan, 1989; Collins et al., 2014), the attraction of a crag deposit so far removed from East Anglia, England, yet accessible from Jamaica, was considerable, posing obvious questions. Examination of various definitions, three of which are quoted above and spanning over 120 years, all more or less agree that crag deposits are fossiliferous, Pliocene-Pleistocene and mainly limited to East Anglia. The Tobago Crag satisfies two of these criteria, apart from the geographical, but note that definition (1) of Whittow (1984; see above) defines crag based on lithology, not location.

The purpose of the present note is to reexamine the Tobago Crag from both East Anglian and Antillean angles. I want to explore its qualification as a crag-like deposit as defined above and to determine the validity, or otherwise, of its geographical isolation. And I want to pursue some ideas for future research on these beds. For general introductions to the geology of Tobago, see Maxwell (1948), Jackson and Donovan (1994) and Snoke et al. (2001).

## 2. THE TOBAGO CRAG

(Adapted, in part, from Donovan, 1989a.) Tobago is an Antillean island located in the south-east corner of the Caribbean Plate (Figure 1). It has



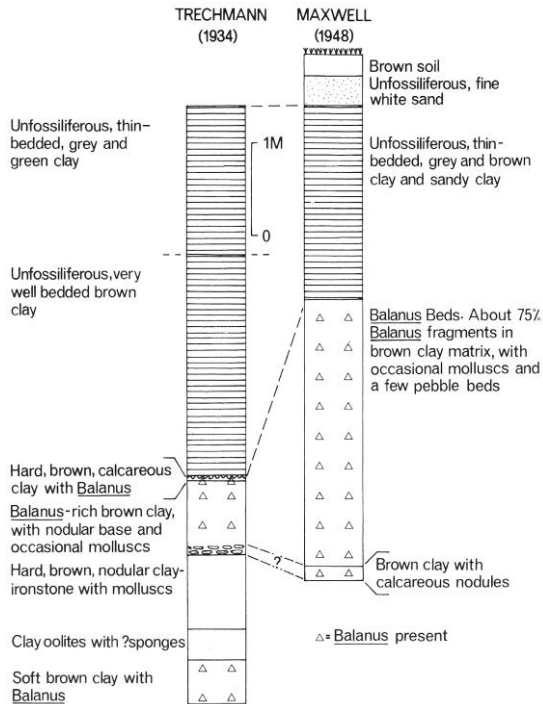
**Figure 1.** Simplified geological map of south-west Tobago (after Lewis and Donovan, 1991, fig. 1; Donovan, 1989a, fig. 1; redrawn after Saunders and Muller-Merz, 1985, fig. 1). The sections in Figure 2 herein were measured at the southwestern end of the outcrop in Rockly Bay. Little Rockly Bay is immediately west of Red Point. The inset map shows the position of Tobago in the eastern Caribbean.

been interpreted as part of an allochthonous terrane that forms the easternmost fragment of the Caribbean Mountain System (Jackson and Donovan, 1994). The island is divided into essentially three provinces: one sedimentary (south-west), one igneous (central) and one metamorphic (north-east) (Jackson et al., 1988). It is the Pliocene or Pliocene-Pleistocene sedimentary rocks of Tobago that are the subject of this review.

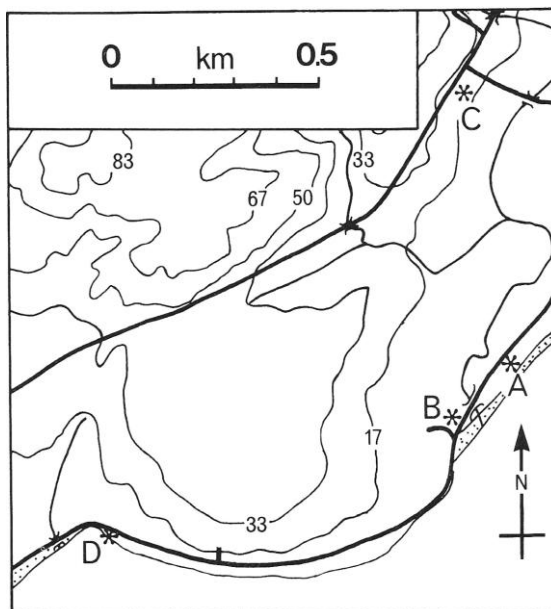
The Tobago Crag – today known more commonly as the Rockly Bay Formation – is comprised of the Balanus Beds or Balanus Clay Beds and the Arca patricia Bed. The balanid is, dominantly, *Megabalanus tintinnabulum* (Linné). Maxwell (1948) interpreted the Balanus Beds as a valley infill of lenticular section (Figures 1 and 2), but it is laterally extensive, being littoral to sublittoral in origin and thinning away from the palaeoshoreline, at least in the type area (Donovan, 1989a). The Balanus Beds may be described as a coquina with many cirripedes preserved in situ, growing on shell debris.

A bed that is dominantly composed of barnacles is an exceptional deposit, a fossil *Lägerstätte sensu* Seilacher et al. (1985) and is unique in the Caribbean region. While other ancient rocky shoreline deposits are known to include an encrusting barnacle fauna, they are apparently rare, although this may be due to a failure of description (Johnson, 1988, 2023). Recent *M. tintinnabulum* is most common sublittorally or on heavily wave-beaten rocks (Southward, 1975, p. 4; Ali and Ayub, 2021) and has a worldwide distribution (Henry and McLaughlin, 1986, p. 18).

The principal features of the Balanus Beds and the associated Arca patricia Bed are best illustrated by reference to four localities in the Red Point area, south-west of Scarborough, the island’s capital (labelled A to D in Figure 3; for the location of Red Point, see Figure 1). These localities show the typical features of the Balanus and Arca patricia beds, while being in close enough association to be linked stratigraphically.



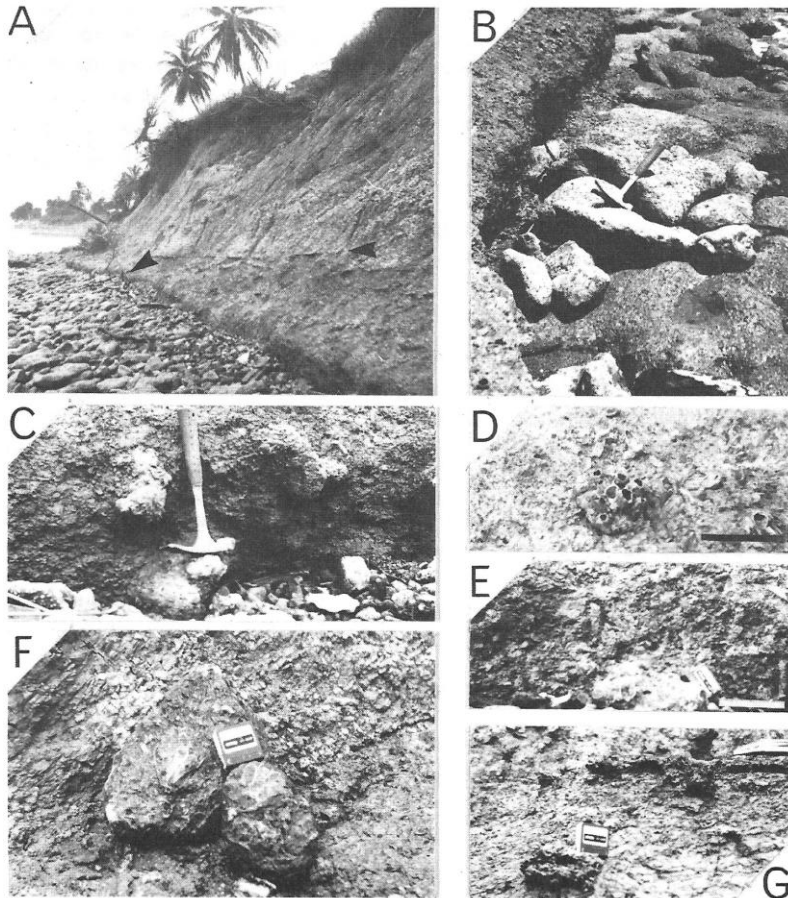
**Figure 2.** Strip logs of two measured sections at the southwestern end of the type section of the Rockly Bay Formation, Tobago, drawn from information in Trechmann (1934) and Maxwell (1948) (after Donovan, 1989a, fig. 2; Jackson and Donovan, 1994, fig. 11.4). Note the apparently large variation in thickness of some beds in two sections measured within 100 m of each other.



**Figure 3.** Locality map of the Red Point area of the south coast of Tobago (see Fig. 1; after Donovan, 1989a, fig. 3). Contours in metres. Rockly Bay Formation outcrops mainly below the 17 m contour. Localities: A=type section, Rockly Bay; B=coast road, southwest of Lambeau River bridge; C =junction of Government Farm Road and highway; D = east side of Little Rocky Bay. Beaches are stippled.

The type section of the Rockly Bay Formation (Figure 3, Locality A) forms a line of low sea cliffs, slumps and beach debris, with undisturbed beds dipping very gently to the south-west (Figure 4A). The sequence is comprised of mainly poorly consolidated, dull coloured clay horizons with uncommon, well-indurated beds with a calcium carbonate cement (Figure 2). About 11 m of the section are exposed (Saunders and Muller-Merz, 1985, p. 340). Macrofossils are concentrated in the Balanus Beds, which can be subdivided into three horizons: a ‘basal’, well-cemented unit (Figure 4B–C, F); an orange-brown to grey clay bed (Figure 4D–E, G); and a well-cemented limestone cap (top of Figure 4G). The ‘basal’ unit is dominated by *M. tintinnabulum*, preserved both as clusters of intergrowing specimens (Figure 4F) and disarticulated plates. Small, decalcified bivalves and gastropods are common, many of them appearing to belong to species not recorded by Trechmann (1934), with rarer decalcified bryozoans, apparently epifaunal on other elements of the fauna (Taylor and Foster, 1994). These decalcified fossils presumably provided a source of cement. Uncommon small igneous, presumably basaltic, pebbles are present, with a maximum diameter of about 20 mm or less. Pebbles are dark green to black in colour and are well rounded with moderate sphericity. This horizon appears to be composed of coalesced nodules with a carbonate cement. However, cementation apart, it appears to be sedimentologically identical to the overlying muddy horizons of the Balanus Bed.

Rounded fragments of the cemented horizon occur as abundant cobbles on the beach (Figure 4B). Additionally, rarer nodules occur within the muddier horizon of the Balanus Bed (Figure 4C). It is undoubtedly the appearance of this cemented horizon that has suggested to previous workers that the Balanus Bed has a channel-like morphology (Figure 2). However, although the thickness of the bed has the appearance of varying within the exposure, it does not have the morphology of a channel. The cemented horizon is parallel to the modern beach surface (Figure 4A–B). Further to the north-east (that is, behind the photographer in Figure 4A), the true base of the gently-dipping Balanus Bed is exposed in the cliff section. This is about 2 m in thickness and the base is a poorly-cemented clay, like most of the bed, with a hint of nodularity. The bedding planes at the top and bottom of the bed are parallel and planar, with no indication of a channel-like morphology. The ‘basal’ nodular unit represents Holocene beachrock-style cementation at about the present high tide mark. The true morphology of the Balanus Bed at the type



**Figure 4.** The Balanus Beds in the type section of the Rockly Bay Formation, Rockly Bay, Tobago (after [Donovan, 1989a](#), fig. 4). **A)** General view of the southwestern end of the section (Red Point in the distance). Balanus Beds dipping to the south-west. Right arrow indicates top of bed, left arrow indicates well-cemented ‘basal’ horizon. **B)** Well-cemented horizon exposed on beach. **C)** In situ nodules. **D)** A cluster of *M. tintinnabulum* in the balanid-dominated mudrock, x 0.13. **E)** Vertical burrows, *Skolithos* isp. **F)** Clusters of *M. tintinnabulum* in water-worn cobbles from the well-cemented horizon. **G)** Top of the bed. Tape measure resting on cluster of balanid fragments. Notebook on balanid limestone ‘cap’. Side of tape measure = 50 mm; shaft of hammer = 280 mm.

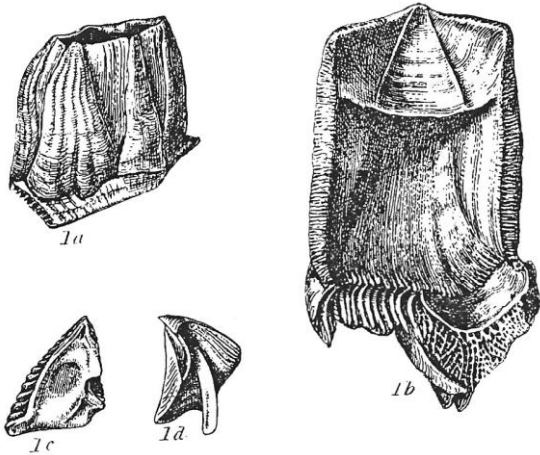
locality is therefore a horizon of about 2 m constant thickness, showing no evidence of channelling.

The ‘overlying’ clay unit is soft and poorly cemented. It is dominated by *M. tintinnabulum* mainly preserved as unabraded, but disarticulated, plates, with occasional complete barnacles, usually occurring in clusters ([Figure 4D](#)). [Maxwell \(1948, p. 843\)](#) reported that similar beds at the Government Stock Farm (to the north of [Figure 3](#)) consists of 80% balanid fragments. A random 1,114 gm sample taken from various points along the type section was found to contain about 60% fragments larger than 210  $\mu\text{m}$  by weight, most of which were balanids or balanid fragments. This is a most unlikely environment for such dense barnacle occupation, lacking any extensive hard substrate for attachment. However, small hard surfaces are not uncommon, particularly balanid plates ([Figure 5](#)), and pebbles, oysters, and pectinaceans; rare echinoid ([Lewis and Donovan, 1991; Figure 6](#) herein) and crab debris, and shark’s teeth ([Donovan et al., 2001; Figure 7](#) herein), were found to lack encrusters. This range of substrates would have been ideal for colonization, modern ([Caffey, 1982](#)) and fossil ([Donovan, 1989a](#)) barnacles being known to show little substrate preference. Once a

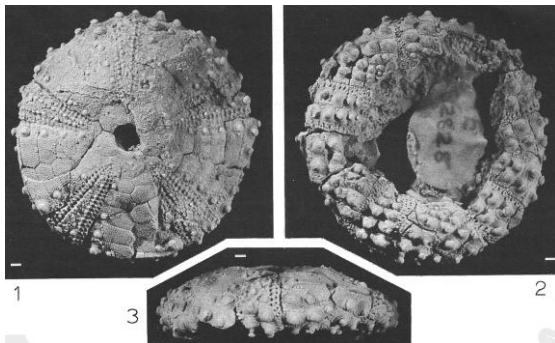
balanid was established, it then became available for encrustation, not just by other barnacles, but also by moderately diverse bryozoans ([Taylor and Foster, 1994](#)) and an unidentified boring organism.

That balanids grew in clusters is not unexpected, as modern acorn barnacles are well known for their gregarious habit ([Lewis, 1977; Barnett and Crisp, 1979; Barnett et al., 1979](#)). Clusters of balanids are usually preserved in life position. It is highly improbable that such irregular and complex structures could have been transported intact and then deposited in their living orientation.

[Saunders and Muller-Merz \(1985, p. 340\)](#) reported “Borings . . . mostly vertical, of 2 cm diameter and often lined with packed, horizontally placed barnacle plates”. In such an unlithified substrate, these ‘borings’ are, of course, burrows ([Figure 4E](#)). My measurements made on 37 burrows, *Skolithos* isp., indicate a mean diameter of 16.3 mm, with a range from 11 to 21 mm ([Figure 8A](#)). All burrows are vertical to subvertical ([Figure 8B](#)), with some long burrows (maximum recorded length is 155 mm, but no burrow appears complete) showing slight changes in orientation along their length. The apparent lining is an artefact of the surrounding sediment being packed with balanid



**Figure 5.** *Megabalanus tintinnabulum* (Linné) (after Darwin, 1855, pl. 1, fig. 1; not from Tobago). **1a**) Small specimen, natural size. **1b**) Rostrum, internal view of a large specimen, natural size. **1c–d**) scutum and tergum.



**Figure 6.** *Arbacia improcera* (Conrad), (Natural History Museum, London) NHMUK E82828 (after Lewis and Donovan, 1991, pl. 1, figs 1-3). **1**) Apical view. **2**) Oral view. **3**) Lateral view. Scale bars represent 1 mm.



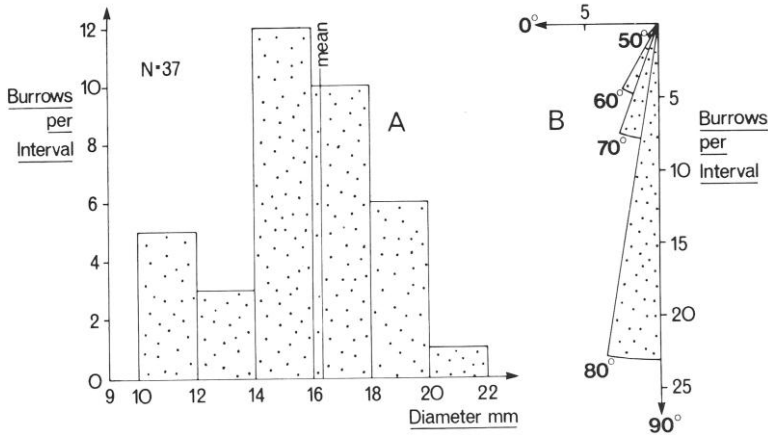
**Figure 7.** *Carcharhinus* sp. cf. *C. limbatus* (Valenciennes), (Natural History Museum, London) NHMUK P65714, tooth (locus uncertain) (after Donovan et al., 2001, fig. 2). **A**) Lingual view. **B**) Profile view. **C**) Labial view. Scale bar presents 10 mm.

plates. If an organism was actively lining its burrow, it would be more energy efficient to orientate the barnacle plates parallel, rather than perpendicular, to the long axis of the excavation. The sediment in the burrows differs from that of the surrounding bed in being paler in colour and better cemented. The presence of vertical burrows indicates the Skolithos ichnofacies (Seilacher,

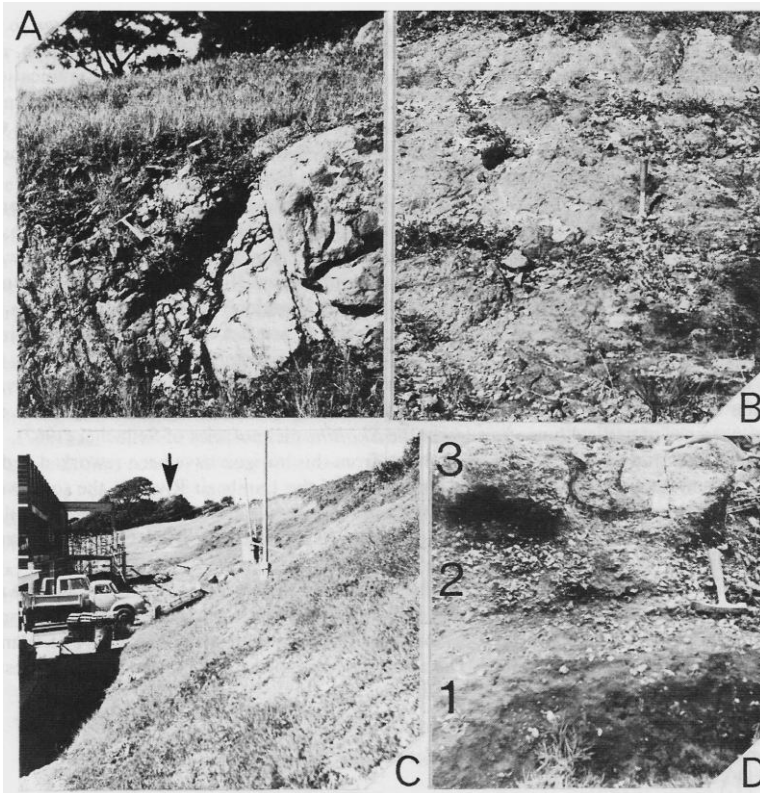
1967; MacEachern et al., 2007).

Numerous balanid plates from this horizon have been reworked and are found in the beach sediment between this locality and the mouth of the Lambeau River to the south-west. In situ plates are largely unabraded, whereas reworked plates in the beach sediment (gravel) show similar signs of wear to balanid fragments in the megaripple facies of the Red Crag Formation (Donovan, 1988). The thin, cemented cap of the Balanus Bed is a barnacle-rich limestone (Figure 4G). There are no clusters of balanids or complete individuals preserved in this horizon, but disarticulated plates are common (Figure 5). No barnacles are found above this level. The limestone cap therefore represents some sort of termination to conditions favourable to balanid dominance. The absence of ‘complete’ balanid shells also suggests that this horizon was associated with a hiatus in sedimentation.

About 200 m south-west of the type section, a second exposure of the Balanus Beds occurs near the Lambeau River Bridge, on the north-west side of the coast road (Figure 3, Locality B). This exposure is about 20 m long by 2 m high, bedding lying approximately parallel to the road surface. This sequence is again dominated by *M. tintinnabulum*, but clusters and individual balanids are recumbent, rather than in life position, with many specimens disarticulated. Balanid shells are sometimes bored and uncommonly encrusted by smaller barnacles. This exposure is topographically slightly higher than the type section. It also dips in the opposite direction, that is, gently to the north-west, suggesting that the two localities are separated by a gentle syncline or fault (Figure 3). The coast road locality also differs from the type section in having a sand, rather than mud, matrix. The section at the coast road locality is illustrated in Figure 9D. This sequence shows a three-fold division quite different from that at the type locality. The lowest horizon, (1), is a poorly cemented, orange-brown, fine-grained sandstone. The sand itself is calcareous and probably rich in balanid debris. Identifiable balanid fragments are rare near the bottom, but plentiful towards the top, particularly in the uppermost 200 mm. The top of this horizon is uneven. Horizon (2) is similar to (1), except that it is straw-coloured and packed with balanids, associated with rare gastropods and pectinaceans. The sandstone in horizon (3) is similar, but large nodules, up to 280 mm thick and packed with balanids, occur near the base. The substrate on which so many barnacles must have grown is not apparent but must have been local to have favoured the excellent preservation seen in many specimens. Shell debris and pebbles may have provided



**Figure 8.** Parameters measured from 37 vertical to subvertical burrows, *Skolithos* isp., in the type section of the Balanus Beds at Rockly Bay, Tobago (after Donovan, 1989a, fig. 5). **A)** Histogram of burrow diameters. Mean = 16.3 mm. **B)** Orientation of burrows. Because the gentle dip of the bed was considered to be approximately equivalent to any error of measurement, no correction has been made.



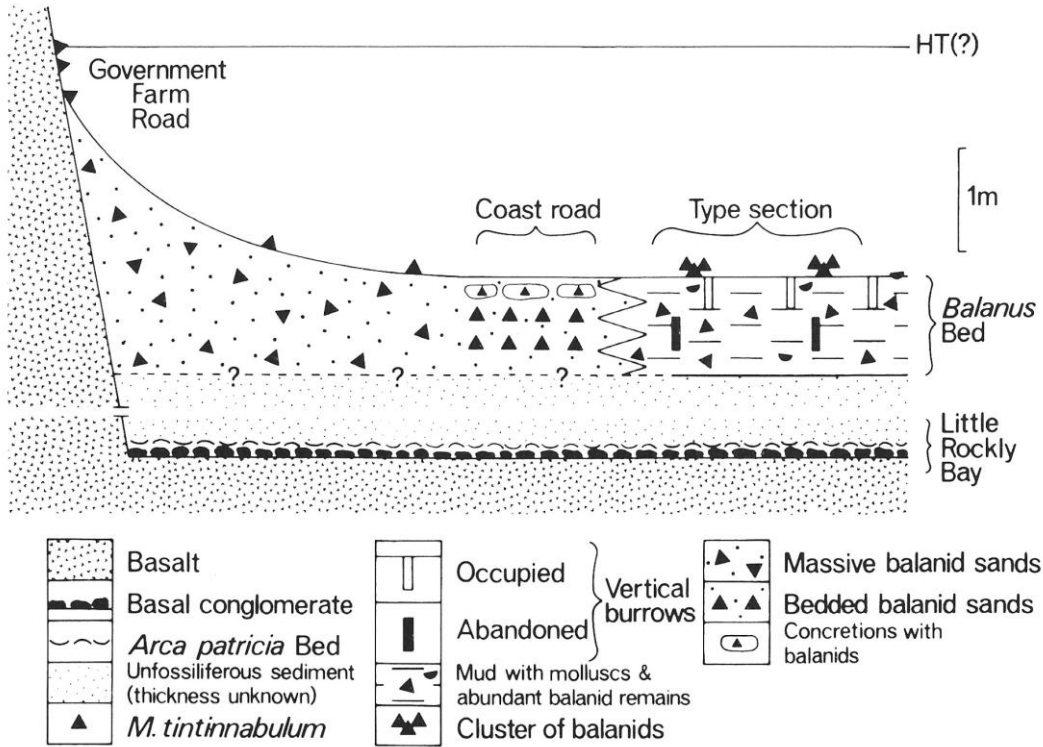
**Figure 9.** A–C) Lithologies at the Government Farm Road-highway section (Locality C). **A)** Fresh basalt. **B)** Weathered basalt (note relic quartz veins). **C)** General view of locality. Fresh basalt hidden by building on left; arrow indicates position of weathered basalt; balanid-rich sands exposed in foreground. **D)** Coast road locality. Horizons 1 to 3 explained in text. After Donovan (1989a, fig. 6).

substrates for many of these shells, as at Locality A, although balanids are more usually preserved as individuals rather than as clusters at Locality B. Cretaceous basalts outcrop about 100 m south-west of the coast road locality.

At Government Farm Road, just to the south-west of junction with highway (**Figure 3**, Locality C) is an exposure close to the contact with the underlying Mesozoic basalts, which are well exposed on the north-west side of the highway and at the south-west end of the exposure (**Figure 9A**). The latter occur about 5 m beneath an exposure of orange-brown, highly-weathered basalt, in which quartz veins are still apparent (**Figure 9B**). This, in turn, is about 150 m south-west of a superficially

similar lithology (**Figure 9C**). However, close examination shows this last exposure to be a sandstone deposit dominated by individual balanids and barnacle debris, with occasional oysters and rare pectinaceans. Bedding is difficult to recognize (strike and dip possibly about 048/20°SE), but this section appears to include 6–7 m of balanid-rich sedimentary rock. Lithological changes within the sequence are not apparent, apart from occasional nodules (compare with Locality B). The top and bottom of this sequence are not seen. The balanid-rich exposure is 50 m wide, but the true thickness and width of the balanid-bearing sediment is not apparent.

The *Arca patricia* Bed at Little Rockly Bay



**Figure 10.** Schematic reconstruction of the palaeoenvironment of the mid-Pliocene Balanus Bed of Tobago (after Donovan, 1989a, fig. 7). The full vertical development of the bed is not shown. Relationships between localities not to scale. Vertical scale approximates both to water depth and bed thickness.

(Figure 3, Locality D) was well described by Trechmann (1934, p. 483) and represents the basal unconformable contact of the Rocky Bay Formation with the underlying Mesozoic basalts. The section outcrops on the east side of the bay but is largely overgrown. However, fallen boulders include part of the basal conglomerate, plus the horizon dominated by disarticulated valves of the large ark *Anadara* (= *Arca patricia* (G.B. Sowerby) in a dark brown sandstone matrix.

From the above descriptions of localities A to C, there are three important general observations concerning the morphology of the Balanus Beds in Tobago.

1. The thickness of the bed decreases dramatically away from the lateral contact with the Mesozoic basalts (that is, C to B and A).
2. Matrix grain size decreases in the same direction.
3. The generally excellent preservation of the balanids suggests that any transport must have been minimal. The presence of plentiful barnacle plates, generally showing little or no abrasion, but which are rapidly abraded upon reworking on the modern beach, suggests that disarticulation was in situ or local with minimal transport.

These conclusions, taken in addition to all available evidence, have led to the tentative palaeoecologic reconstruction of the habitat of the Balanus Beds which appears in Figure 10. Two types of unconformable contact with the Cretaceous basalts are discernible within the Rocky Bay Formation, one basal, the other lateral. The *Arca patricia* Bed in Little Rocky Bay (Locality D) overlies an undoubted basal conglomerate, but the precise relationship between this horizon and the other localities described herein is uncertain. However, it seems certain that the *Arca patricia* Bed is the oldest sequence within the Rocky Bay Formation (Figure 10). The lateral unconformity is recognized in the sequence of deposits at the Government Farm Road (Figure 10, Locality C). In this area, sediment was being produced by the weathering of basalt, either in situ or with minimal local transport, perhaps largely under the influence of gravity. The only obvious differences that are discernible in the field between the weathered basalt and the fossiliferous sediment are that the former is veined, while the latter is highly fossiliferous. The weathered groundmass and the matrix, respectively, of the two rock types are very similar. This locality is topographically about 17 m higher than the type section, apparently suggesting a large tidal range

(Maxwell, 1948, reported the Balanus Beds outcropping at 50 m), in obvious contrast to the modern range in the Caribbean of only about 1 to 2 m. These anomalous variations in altitude are more probably the result of faulting, a rapid rise in sea level, or the bed having a particularly wedge-shaped geometry. There is little obvious evidence for faulting in this area. That the bed must be wedge-shaped is indicated by the differences in bed thickness between localities A/B and C. However, the middle Pliocene also experienced a sea-level rise of about 100 m, as indicated by sea-level curves for the post-Palaeozoic (e.g., Haq et al., 1987). Barnacles may therefore have been thriving during a time of marine transgression, invading the basalt outcrop to form a diachronous, wedge-shaped bed, although this may also have involved a tectonic component (= Pleistocene tectonism; Wadge and Hudson, 1986).

Previous use of fossil barnacles in sea-level studies has been largely limited to the detection of the relative rate of marine regression in Holocene sequences (e.g., Pirazzoli et al., 1985). The Tobagonian deposition suggests that balanids may also be used as indicators of marine transgression. Johnson (1988, table 1) listed references to a number of encrusting communities, several of which, back to the Campanian, include or are dominated by barnacles. However, barnacles in such environments are usually disarticulated with no complete shells preserved (for example, Leithold and Bourgeois 1984; Zullo et al., 1987), unlike the Balanus Beds in Tobago. Attention is drawn to the example of a Pliocene transgressive sequence in Egypt (Aigner, 1983), which includes encrustation by a wide range of organisms, including balanids. However, rocky shorelines have largely been neglected by palaeontologists (Johnson, 1988, 2023), so barnacle-encrusted shorelines like the Balanus Beds may be much commoner than is currently recognized.

Why the Tobagonian deposit should be dominated by balanids, and not some other encruster, is problematic, although oysters (Trechmann, 1934), bryozoans (Taylor and Foster, 1994) and borings are also present in the fauna. Many rocky shorelines are dominated by balanids at the present day, a group that has undergone a major radiation since they first appeared in the Eocene (Darwin's 'Age of Barnacles'). Balanids were probably living attached either to the basalt or to bioclasts and pebbles at Locality C. That suitable substrates for attachment were plentiful is suggested by the lack of adult balanids overgrowing each other. Bedding is difficult to discern at this locality. The shells of

bivalves appear to be thicker at this locality than in the type section, perhaps supporting the deduction that higher energy conditions prevailed in the more near-shore environment. The Balanus Beds thin away rapidly from the lateral basalt contact (Figure 10). The coast road section (Locality B) attains a thickness of 1.7 m, although the top, and possibly the bottom, of the bed are not seen. This section is only about 100 m from an outcrop of basalt. However, it is uncertain whether this nearest basalt outcrop was a source of sediment, the exposure appearing fresh. Bedding is apparent in the coast road section, indicating occasional breaks in sedimentation. Preservation of balanids is similar to that at Locality C, despite the absence of an immediately local basalt outcrop for attachment. It may be that the abundant balanid shell debris provided sufficient substrates for attachment. Alternatively, barnacles may have been concentrated by storm action.

The type section (Locality A) differs from other localities described in being a muddy facies (Figure 10). Stratification is emphasized by the presence of plentiful disarticulated balanid plates lying parallel to bedding. The presence of vertical burrows in this section indicates that it lies within the Skolithos ichnofacies, suggesting that this bed originated in the littoral or shallow sublittoral zone. The necessity for *M. tintinnabulum* to grow in clusters in such an environment has already been discussed. However, the presence of small pebbles and regular echinoids in such a muddy environment requires explanation. Pebbles may have been dropped during sediment transport, perhaps simply rolling downslope under the influence of gravity, but in this case, it would be expected that more non-balanid, sand-sized sediment grains might also be present. It is therefore suggested that pebbles were possibly formerly attached to the basal disc of marine algae which broke free from more shoreward attachment. Echinoids have been identified from the tests of *Arbacia improcera* (Conrad) (Figure 6) and spines of *Eucidaris tribuloides* (Lamarck) (Lewis and Donovan, 1991). At the present day, the latter species is usually found either hidden in crevices or camouflaged by sea grass, emerging at night. That the type section was possibly stabilized by sea grass is suggested by the presence of a diverse fauna of benthic foraminiferans (Saunders and Muller-Merz, 1985).

### 3. DISCUSSION

Based on lithology and age, the Balanus Beds are acceptable as a Crag deposit. Tobago is a long way from East Anglia, but satisfies definition (1) of

Whittow (1984, p. 121; see Introduction). I therefore accept it as a crag, although not an East Anglian crag; I expect others to disagree.

I choose to write this discussion around a series of pertinent questions. For example, why did Trechmann choose to call this deposit a Crag? The question is not trivial. Trechmann, apart from some departures into regional tectonics and mountain building late in life (e.g., Trechmann, 1955), is known for his palaeontological and stratigraphic studies of two regions, north-east England (mainly Permian and Quaternary) and the Antilles (Upper Cretaceous and Cenozoic) (Donovan, 2001, 2003). He published on the Neogene of the Antilles, particularly the molluscs, such as Tobago (Trechmann, 1934), but it is not known how well he knew the crags of East Anglia. Perhaps he knew them well enough to make a direct comparison but why refer a Caribbean shelly deposit to a crag is uncertain. Trechmann was unorthodox and idiosyncratic (Coates, 1965; Donovan, 2003, p. 347), but he may not have originated the crag association in Tobago: "... the typical Tertiary red or brown nodular clay or Tobago "Crag" as it has been called ... [my italics] (Trechmann, 1934, p. 483), but by whom?

How similar is the Tobago Crag to the Crag of East Anglia? To be honest, if Tobago was in East Anglia, then the appellation Tobago Crag would raise few comments. The *Balanus* Beds are rich in shelly remains, both balanids and molluscs. They have not been sampled for new molluscan taxa since Trechmann in the 1930s. My own investigations of palaeoenvironment involved only limited fossil collecting, yet still yielded taxa assignable to previously unrecorded groups, such as echinoids (Lewis and Donovan, 1991), sharks (Donovan et al., 2001) and bryozoans (Taylor and Foster, 1994). There are certainly more molluscs to

be identified; although tropical rather than temperate/arctic taxa as found in East Anglian crags; when the Tobagonian fauna is more completely demarcated, then its similarities (or otherwise) to East Anglia may be more obvious. Similarly, Taylor and Foster (1994) must be considered a preliminary study. The East Anglian crags are rich in bryozoans (Taylor and Taylor, 2012) and Tobago will surely yield more.

What next? I do not anticipate returning to the field in Tobago, sad to say, but someone needs to. It would be a fine field area for an undergraduate project or a research degree. There is obviously a need for detailed collecting in the pursuit of new macrofossil taxa, perhaps new groups. For example, crabs await identification from their fragments; asteroids and ophiuroids are likely present as disarticulated ossicles; and borings have yet to be identified. The Tobago Crag is of only limited areal extent but has had almost 40 years since I last collected there, ample time for further exceptional fossils to be exposed by erosion. Both selective picking and bulk sampling promise much. I leave the question of 'Is this a Crag?' to the next generation of collectors, although I have made my own mind up; yet it would be a shame to find a definitive answer too soon.

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