Beast Cliff (Robin Hood's Bay)

[TA 002 996]–[TA 005 988]

Introduction

A number of plant-bearing horizons crop out along this stretch of the coast within the Saltwick and Cloughton Formations. Many species that are seldom found at the other Yorkshire Jurassic localities occur here. Approximately 60 species have been recorded from Beast Cliff (Figure 3.36), including some notable rarities.

The site has long been known as a source of Jurassic plant fossils. Halle (1913) and Kendall (1913) recorded examples of in-situ *Equisetum* in the cliffs at Robin Hood's Bay. Wilson and Yates (1953) described some dicksoniacean ferns and Harris (1946a, 1949a,b, 1951, 1952b, 1953) described bennettite fronds and scale leaves from here. Fragments of the conifer *Brachyphyllum* were described by Kendall (1947). However, it was not until Harris (1961a, 1964, 1969, 1979a; Harris *et al.,* 1974) published his monographs on the Yorkshire Jurassic floras that the full importance of the site became evident.

Description

Stratigraphy

Vertical variation is well marked in the coastal exposures of the Saltwick Formation (Aalenian), which is seen clearly in the channel sandstone deposits. In the Beast Cliff sections there are large composite bodies of multiple channel origin, while mixed sand–silt channel fills in the upper part suggest tidal influence (Livera and Leeder, 1981). Basal loading and soft sediment deformation is also common towards the top. This, together with other upward trends of fewer root beds and increased amounts of drifted plant remains, indicates a change from a well-drained floodplain complex to a saturated swampy environment drained by smaller, mixed-load channels. Thin coal seams seen in the cliffs represent the accumulation of plant debris, notably *Equisetum,* in relatively small, shallow lagoons.

The Eller Beck Formation (Bajocian) represents an inundation and marine transgression that resulted in a sequence that begins in basal ironstones and proceeds upwards into shales and medium-grained sandstones. However, the succeeding Cloughton Formation (also Bajocian in age) marks a return to non-marine conditions, with root beds that indicate fresh water and dense colonization by plants. Further root beds and thin coal seams indicate more, well-developed stands of *Equisetum.*

Harris (in manuscript) listed 12 main plant beds at Beast Cliff; these are shown with other beds in (Table 3.4). Most are in the Saltwick Formation, but one (the Petard Point Bed) is in the Cloughton Formation.

Palaeobotany

The list of about 70 plant species found at Beast Cliff is included in (Table 3.1). It is the only known locality for *Bennetticarpus diodon,* and the type locality for another eight species: *Schizoneura stenophylla, Ctenis exilis, Deltolepis calyptra, D. mitra, Nilssonia syllis, N.* sp. B of Harris (1969), *Cycadolepis spheniscus and Marskea jurassica.* However, this does not provide a complete picture because the various plant beds at Beast Cliff reveal different assemblages of species. One of the best known of these is the *Equisetum* Bed in the cliff, known also from a number of such localities in the area (Halle, 1913; Kendall, 1913). Here *Equisetum columnare* can be found with erect unbranched stems preserved as three-dimensional casts that are typically 40–50 mm wide. Harris (1961a) described the stems as gregarious (occurring 0.1–0.2 m apart and always broken off at the same level between 0.05 and 0.1 m from the base). They probably grew in a pure stand rooted in peaty silt in a pool. When the pool was suddenly overwhelmed with silt the plants died and the stems broke off, allowing sediment to invade their hollow interiors. The rhizomes and peaty soil around them formed a thin coal seam with the roots preserved in the silt beneath. Cone fragments have been found in association with

the stems. It is not yet known whether they were borne terminally or on the tips of branches. Fragments of the fern *Dicksonia mariopteris* are also present in the *Equisetum* Bed, presumably representing plants that were growing around the edge of the *Equisetum* stand.

Harris (1961a) has described two other members of the Equisetales from Beast Cliff. *Neocalamites nathorstii* stems and leafy twigs occur together with the conifers *Elatides thomasii* and *Elatocladus ramosus.* This is the only known locality for the few specimens of *Schizoneura stenophylla,* which Harris found in 1957 in a fallen block of clay-ironstone near Prospect House (Harris, 1961a). *Schizoneura is* a common genus of the Permian of Gondwana, although the type species is widespread in the Triassic rocks of Europe. This is the only unequivocal record of the genus in Jurassic strata.

(Table 3.4) The locations of the plant beds identified by T. M. Harris (in manuscript) at Beast Cliff.

				[GR added 2023]
	Coal 1 in cliff foot	54° 23' 47"	0° 28' 11"	[NZ 99584 00874]
	North *Ptilophyllum* Bed	54° 23' 37"	0° 28' 4"	[NZ 99583 00905]
	Coal 4 in cliff foot	54° 23' 38"	0° 28' 4"	[NZ 99656 00845]
	Solonites Bed (fallen block below Ashyard Farm)	54° 23' 36"	0° 28' 0"	[NZ 67268 00069]
	Fern Bed	54° 23' 30"	0° 57' 56"	[OV 00240 00548]
	E. beani Bed (fallen)	54° 23' 26"	0° 27' 28"	[NZ 99957 00295]
	Coniopteris tatugensis Bed (fallen)	54° 23' 18"	0° 27' 44"	[OV 00778 03992]
Lower Deltaic Series (Saltwick Formation)	Rocky Point *Ptilophyllum* Bed	54° 25' 17"	0° 26' 54"	[TA 00565 98916]
	Elatides and *Neocalamites* Bed (fallen)	54° 22' 33"	0° 27' 12"	[TA 00935 98492]
	Ptilophyllum Bed (near Petard Point in cliff foot)	54° 22' 19"	0° 26' 52"	[NZ 99563 00997]
	Otozamites Bed	54° 23' 41"	0° 28' 5"	[TA 01038 97907]
	Equisetum Bed	54° 22' 0"	0° 26' 47"	[TA 01174 97477]
	Red House Plant Bed (fallen)	54° 21' 46"	0° 26' 40"	[TA 01159 97353]
	Ripple-marked sandstone	54° 21' 42"	0° 26' 41"	[TA 01011 98339]
	Otozamites Bed	54° 22' 14"	0° 26' 48"	[NZ 99527 00996]

	Shale 1 over Eller Beck Bed (EBB)	54° 23' 41"	0° 28' 7"	[NZ 99530 00842]
	Shale and Coal 3 over EBB	54° 23' 36"	0° 28' 7"	[NZ 99680 00567]
	Shale 5 over EBB	54° 23' 27"	0° 27' 59"	[NZ 99699 00536]
	Shale 6 over EBB	54° 23' 26"	0° 27' 58"	[NZ 99813 00260]
	Shale 7 over EBB	54° 23' 17"	0° 27' 52"	[TA 00901 98398]
Middle Deltaic Series (Cloughton Formation Sycarham Member)	Petard Point Plant Beds, black shale over EBB (upper and lower)	54° 22' 16"	0° 26' 54"	[TA 00925 98151]
	A above EBB B above EBB C above EBB D above EBB E above EBB	54° 22' 8"	0° 26' 53"	[TA 01081 97598]
	F above EBB G above EBB	54° 21' 50"	0° 26' 45"	[NZ 67268 00069]

The *Otozamites gramineus* Bed contains a large flora. Harris claimed that it was not known before he began his work on the Yorkshire floras. He found the bed to be accessible for only a few metres horizontally and when exposed again, it (or perhaps another bed at about the same horizon) had a different flora (Harris, 1969). *O. gramineus* is common and found together with the scale leaf *Cycadolepis spheniscus,* here at its type locality. The two occur together at four locations, so most probably belong to the same plant (Harris, 1969). The gynoecium *Bennetticarpus litchi* also occurs here associated with *O. gramineus,* but elsewhere *B. fragrum* occurs with this leaf hence creating a problem because the case for biological linkage is as good for either. The ferns *Cladophlebis haiburnensis, Kylikipteris arguta, Klukia exilis* and *Aspidistes thomasii are* common, as is the cycad leaf *Nilssonia syllis,* which is found in association with the scale leaf *Deltolepis mitra,* known only from this locality. The two are, therefore, presumed to come from the same plant (Harris, 1964). The conifer shoot *Marskea jurassica* is found here with cones attached.

Other interesting associations have been encountered at Beast Cliff. In sandstone at the foot of Rocky Point, a bennettitalean bud was found in association with plentiful *Ptilophyllum pectinoides* leaves where nothing could be determined. It consists of closely overlapping *Cycadolepis hypene* scales that Harris (1969) suggested enclosed the female flower *Williamsonia hildae.* The bud was at the top of a slender *stem, Bucklandia pustulosa,* which also bore a *Ptilophyllum pectinoides* leaf. All these cases of associated specimens are immensely valuable in showing how otherwise biologically isolated organs originated from the same parent plant.

The Fern Bed has yielded *Coniopteris burejensis, C. concinna, C. murrayana* and the common *Todites princeps.* Van Konijnenburg-van Cittert (1978, 1989) has described the in-situ spores of the last three species from specimens collected here.

The type locality for the rare pteridosperm *Ctenis exilis* is Harris' Bed A where he found three more or less complete pinnae and many minute cuticle fragments.

Interpretation

There is clearly considerable potential for further work at Beast Cliff; Harris having only scratched the surface of its palaeobotanical interest. It has already been shown that species occur here that are rare or absent from most of the other Yorkshire Jurassic localities. These include *Schizoneura stenophylla, Dicksonia mariopteroides, Coniopteris burejensis, Ctenis exilis, Nilssonia syllis, Deltolepis mitra* and *Paracycas cteis.* The Beast Cliff plant beds therefore seem to represent habitats that were different from those indicated by other sections in the Yorkshire Jurssic. Further discoveries of unusual plants can thus be expected in the future.

The large number of different assemblages at Beast Cliff reflects changing environments of sedimentation. The shallowest conditions permitted *Equisetum* to flourish and spread across the lagoons. Sudden influxes of sediment into these lagoons would have killed the entire stand, leading to rotting of the apical parts of stems and sand filling their hollow centres. Renewed colonization could have been initiated by survivors around the fringes of the lagoons if the depth of water was right. If it was too deep then *Equisetum* would have been restricted to the fringes, behind which would have been ferns, cycads and bennettites.

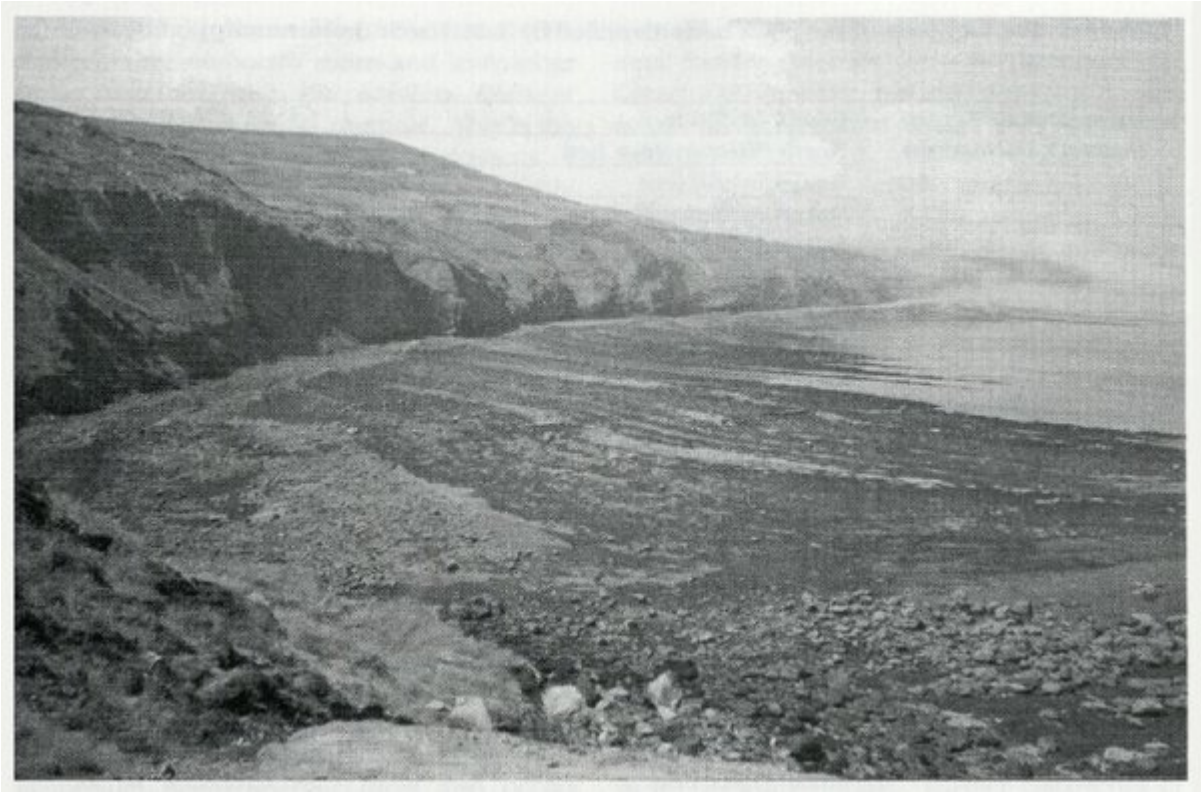
The large assemblage found in the *Otozamites gramineus* Bed suggests that there was a diverse local flora. However, although *O. gramineus* is common and found together with some of its reproductive organs, the associated plants in the various fossiliferous lenses vary greatly. This suggests that *Otozamites* colonized the fringes of the lagoon whereas the surrounding plants had no particular spatial arrangements. Fern remains are common but they are different from the species encountered in the Fern Bed, which presumably represents a very local assemblage.

The association of the equisetalean *Neocalamites nathorstii* with the conifers *Elatides thomasii* and *Elatocladus ramosus* suggests that they were growing together, probably some way up the river system inland. The conifer shoot *Marskea jurassica,* being found here with attached cones, had probably not travelled far before being incorporated into the sediment.

Conclusion

Beast Cliff has yielded a range of plant fossil assemblages with many species that are relatively rare in the Yorkshire Jurassic succession. The association of leaves with reproductive organs provides vital evidence for reconstructing whole plants. The many different assemblages were preserved in several different ways, showing how they can be related to sedimentation. The *Equisetum* stands preserved in growth position are important examples of in-situ fossilization.

References



(Figure 3.36) View across Robin Hood's Bay towards Beast Cliff. (Photo: H.S. Morgans.)

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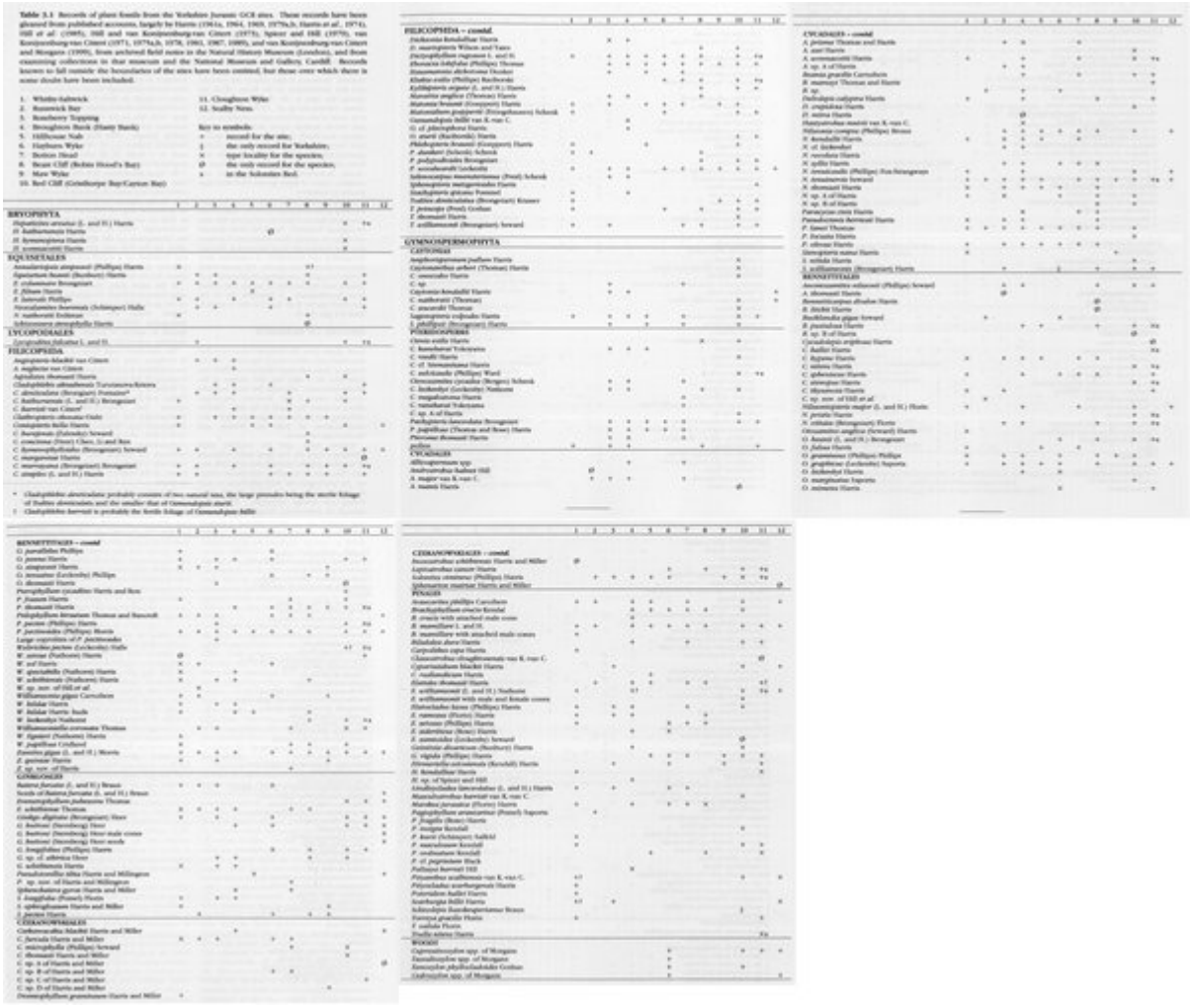

(Table 3.1) Records of plant fossils from the Yorkshire Jurassic GCR sites. These records have been gleaned from published accounts, largely by Harris (1961a, 1964, 1969, 1979a,b; Harris et al., 1974), Hill et al. (1985), Hill and van Konijnenburg-van Cittert (1973), Spicer and Hill (1979), van Konijnenburg-van Cittert (1971, 1975a,b, 1978, 1981, 1987, 1989), and van Konijnenburg-van Cittert and Morgans (1999), from archived field notes in the Natural History Museum (London), and from examining collections in that museum and the National Museum and Gallery Cardiff. Records known to fall outside the boundaries of the sites have been omitted, but those over which there is some doubt have been included.