Cloughton Wyke

[TA 010 951]

Introduction

The beds of the Cloughton Formation (the 'Middle Deltaic Formation' of earlier authors) exposed in Cloughton Wyke are well known for their abundant well-preserved plant fossils. Over 70 species have been recorded. Common genera include the bennettitaleans *Ptilophyllum* and *Otozamites* and the fern *Coniopteris.* Among the more important members of the flora are *Beania mamayi* and *Androstrobus wonnacottii,* the female and male cones of *Nilssonia tenuinervis.* These three taxa have enabled a reconstruction of the parent cycad to be made. The site is of national importance, especially for systematic studies of gymnosperms.

The site has long been the subject of palaeobotanical research. Leckenby (1864) collected plant fossils from the Cloughton Wyke exposure in the early 19th century and many were figured and described by Phillips (1829, 1835). Later, Nathorst (1880) and Halle (1911) sampled here; their collections now being housed in the Natural History Museum, Stockholm. It is the type locality for a species of the ginkgophyte leaf genus *Eretmophyllum,* which was erected by Thomas (1913), and Kendall (1947, 1948) described shoots of the conifers *Brachyphyllum* and *Pagiophyllum* from here. However, the most extensive studies on the site were those of Harris (1943b, 1946a,b, 1948, 1951, 1952a,b, 1953), culminating in his monographs (Harris, 1961a, 1964, 1969, 1979a; Harris *et al.,* 1974). More recently, the palaeobotany of the site has been investigated by van Konijnenburg-van Cittert (1981, 1987) and Morgans (1999).

Description

Stratigraphy

The stratigraphy of the section at Cloughton Wyke is summarized in (Figure 3.46). It begins with a hardground that is overlain by a storm-derived conglomerate and beach deposits. This is interpreted as the Millipore Bed (within the Cayton Bay Formation), which was probably deposited as a southerly migrating strand line (Livera and Leeder, 1981). The overlying Yons Nab Beds, which comprise the lowest part of the Gristhorpe Member, are exposed in the low cliff and are interpreted to represent part of a system of sand ridges separated by lagoonal deposits. In the centre of the wyke, the overlying beds are exposed in the cliffs and the rock platform. The lowest part consists of well-bedded mudstones, and siltstones with thin coals. The lowest coal was probably formed from drifted plant material. Fragments of *Equisetum* are found associated with some of the bedding planes showing root penetration. Surfaces showing burrows of the trace fossil *Diplocraterion* are also present.

Two metres of sandstones dominate the middle part of the member. These display a wide range of sedimentary features, including horizontal to wavy lamination, wave-ripple cross-lamination, planar lamination and small-scale trough cross-lamination. The upper part of the Gristhorpe Member consists of about 7 m of channel sandstones, siltstones and mudstones with rootlet beds. These include the major lacustrine plant-rich beds at Cloughton Wyke. Above are sheet sands/sandstones of crevasse-splay origin, which dominate the middle part of the Gristhorpe Member (Livera and Leeder, 1981).

Harris (in manuscript) listed 17 separate plant fossil localities at Cloughton 'Wyke; these are summarized in (Table 3.6).

(Table 3.6) The locations of the plant beds identified by T.M. Harris (in manuscript) at Cloughton Wyke.

			[GR added 2023]
Black Shale B	54°20'21"	0°25'45"	[TA 02225 94872]
Black Shale A	54°20'25"	0°25'51"	[TA 02114 94993]
Equisetum Bed in waterfall	54°20'25"	0°25'51"	[TA 02114 94993]

3 ft 6 ins [=1.1 m] shaky sandstone	54°20'26"	0°25'51"	[TA 02114 95024]
Solonites Bed	54°29'28"	0°25'42"	[TA 01902 11778]
Eretmophyllum Bed	54°20'31"	0°25'45"	[TA 02218 95181]
Fern Bed	54°20'36"	0°25'40"	[TA 02305 95337]
Pachypteris Bed (10 ft [=3 m] sandstone)	54°20'36"	0°25'43"	[TA 02251 95336]
Equisetum laterale Bed (9 ft [=2.7 m] sandstone)	54°20'37"	0°25'43"	[TA 02250 95367]
quinqueloba Bed			
Coal Bed	54°20'40"	0°25'43"	[TA 02248 95460]
Neocalamites Bed			
2 ft 6 ins [= 0.8 ml Drifted Plant Bed	54°20'50"	0°25'47"	[TA 02169 95767]
Phlebopteris Bed (fallen)	54°20'51"	0°25'48"	[TA 02151 95798]
Base of Millipore Bed	54°20'54"	0°25'49"	[TA 02130 95890]
Otozamites bunburyanus Bed	54°20'55"	0°25'49"	[TA 02130 95921]
Zamites Bed	54°20'54"	0°25'49"	[TA 02130 95890]
15 ft [= 5 m] below Millipore Bed	54°20'55"	0°25'49"	[TA 02130 95921]
(*Otozamites beanii) Nilssonia* Bed	54°20'56"	0°25'49"	[TA 02129 95952]

Palaeobotany

The Cloughton Wyke plant beds have yielded 73 taxa (see (Table 3.1); (Figure 3.47)). Remains of ferns, cycads, bennettites and conifers are especially common, but bryophytes, clubmosses, horsetails, caytonias, pteridosperms, ginkgophytes and czekanowskias have also been found. It is the type locality for 12 species: *Coniopteris margaretae, Bucklandia pustulosa, Cycadolepis eriophous, C. hallei, Nilssoniopteris pristis, Pterophyllum thomasii, Ptilophyllum pecten, Weltrichia pecten, Classostrobus cloughtonensis, Hirmeriella kendalliae, Pagiophyllum ordinatum* and *Trulla nitens.* For *Coniopteris margaretae, Cycadolepis eriophous* and *Classostrobus cloughtonensis* it is the only known locality. As with many other palaeobotanical sites in the Yorkshire Jurassic succession, however, a simple compilation of species tells only part of the story of the plant diversity at Cloughton Wyke. The different plant beds found by Harris (in manuscript) vary in content and importance, reflecting differences in both source vegetation and taphonomic histories. The *Solonites* Bed is the most significant and certainly contains the largest number of species (identified by an 's' on (Table 3.1)). It is most probably a lagoonal deposit incorporating the many species that grew around the edge of the water and in the near vicinity. *Solonites vimineus,* from which the bed takes its name, is very abundant; so common in some places that its matted leaves form a paper coal (Harris, 1974a). The bryophyte *Hepaticites arcutus* occurs here, and there are large numbers of pteridophyte remains, including the relatively rare *Lycopodites falcatus,* and *Kylikpteris arguta* (the spores of which have been described by van Konijneburg-van Cittert, 1989). A number of important gymnosperms have also been found, including cycad cones and leaves; bennettite flowers, leaves and scale leaves; and conifer shoots with cones.

The *Nilssonia* Bed (discovered in the late 1940s or early 1950s by Wayne Fry and Serge Mamay) also contains abundant cycad remains, but this time it is the leaf *Nilssonia tenuinervis* (the only species here) and associated cones and bud scales.

The other beds yield much poorer assemblages although a few important finds have been made in them. For instance, the only remains of the fern *Coniopteris margaretae* have been found in the *quinqueloba* Bed of Harris along with *C. simplex, C. murrayana, Hepaticites arcutus, Lycopodites falcatus, Nilssoniopteris pristis* and *Ginkgo longifolius.* Van Konijnenburg-van Cittert (1987) reported abundant conifer remains from a loose block that probably originated from this bed.

The *Zamites* Bed, which is just above the Millipore Bed, is thought to be an autochthonous assemblage in which *Zamites gigas* is present along with masses of isolated leaves of *Pagiophyllum masculosum,* which in turn is associated with ovuliferous cone scales (*Hirmeriella kendalliae*) and huge numbers of *Classopollis* pollen grains.

Van Konijnenburg-van Cittert (1981, 1989) described the in-situ spores of *Coniopteris margaretae, C. hymenophylloides, C. simplex, Klukia exilis, Kylikipteris arguta* and *Todites denticulatus* from specimens collected from the Cloughton Wyke plant beds, and Morgans (1999) has recently described fragments of *Cupressinoxylon* spp. from woody horizons.

Interpretation

The Jurassic flora at Cloughton Wyke provides an important complement to the more diverse asssemblages from the Cloughton Formation at Red Cliff. Although there are some species unique to the *site (Coniopteris margaretae, Cycadolepis eriophous*) it is especially valuable for the associations of different plant organs, which help in the development of whole-plant reconstructions. For instance, abundant *Solonites vimineus* leaves in the *Solonites* Bed are associated with ovules of *Leptostrobus cancer,* which Harris has shown to occur together in six other Yorkshire localities. These are presumed to be biologically linked to the same czekanowskialean parent plant. There are some capsules here with relics of seeds and, although no complete seeds have yet been found, Harris suggested that a special search might prove worthwhile. In the same bed there are also associations between the cycad leaf *Nilssonia tenuinervis* and its supposed cone *Androstobus wonnacottii;* the bennettite leaf *Ptilophyllum pecten* and its supposed stem *Bucklandia pustulosa;* and *Cycadolepis stenopus,* the biologically related leaf *Pterophyllum thomasii* and the cones *Williamsonia leckenbyi* and *Weltrichia pecten* (numerous here in its type locality). There are also fine specimens of the conifer *Elatides williamsonii,* frequently with intact seeds.

The *Nilssonia* Bed is important because of the association of three cycad organs: the leaf *Nilssonia tenuinervis* (the only *Nilssonia* species present), the cone *Beania mamayi* and the bud scale *Deltolepis calyptra.* Harris found the scales only after a deliberate search, illustrating how important it is to realize which associated organs are worth looking for in any one site.

Van Konijnenburg-van Cittert (1987) collected good shoots of *Pagiophyllum masculosum* from the foot of the cliff to the south of the *quinqueloba* Bed. In close association was a female cone, *Hirmeriella kendalliae,* and three small pollen-producing cones, which she called *Classostrobus cloughtonensis* after the *Classopollis* pollen that it contained and the site from which it was recovered. This suggests that these organs can be linked to form the basis of a whole-plant reconstruction for one of the cheirolepidiacean conifers in the Yorkshire Jurassic strata.

An accumulation of abundant leaves almost entirely referrable to the pteridosperm *Pachypteris lanceolata* is present in the aptly called *Pachypteris* Bed. Although it has yet to be investigated in detail, a thorough search of this bed might well yield associated organs. The bennettite scale leaf *Cycadolepis eriphous* was found in fallen blocks along with *Otozamites mimetes;* this would also merit further investigation for evidence of additional association.

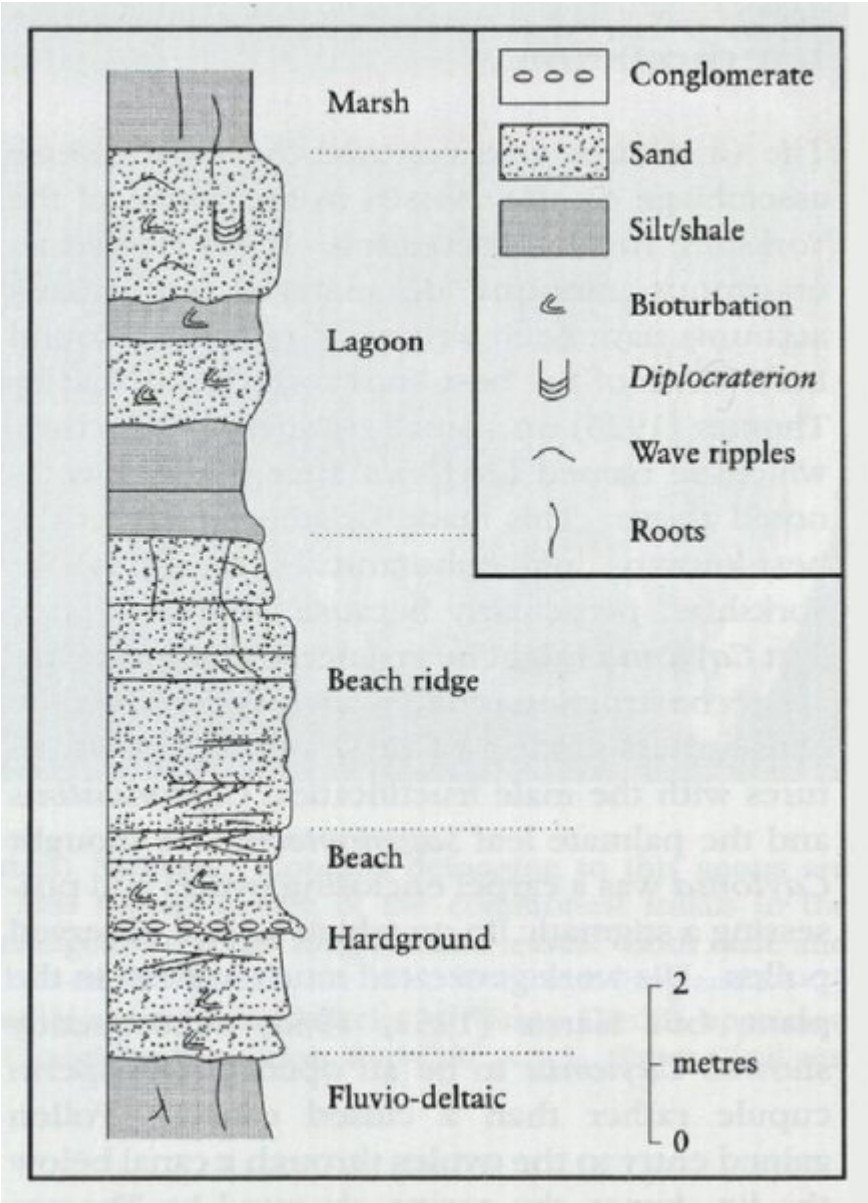
Cope *et al.* (1980a) interpreted the Millipore Bed as having been deposited as a southerly migrating strand line over the Sycarham Member and the overlying Yons Nab Beds as part of a pro-grading system of sand dune ridges separated by silt-dominated lagoonal deposits. They suggested that the environment was equally influenced by tides and waves. A thin coal with poor root foundation that can be seen in the basal shales was most probably formed by plant remains drifting into a lagoon. This lagoonal interpretation is supported by palaeobotanical data, the assemblages of well-preserved plants suggesting minimal transportation from a surrounding vegetation.

The *Solonites* Bed is the main plant bed at Cloughton Wyke. It contains a third of the species recorded for the site, which is more of a mixture of plants than is found in the other beds. Hence it is possible that some of these, such as *Otozamites beanii,* were not part of the immediate vegetation but were brought into the lagoon by a river. The lagoons must have gradually filled with sediment, *Equisetum* eventually colonizing the shallows and giving rise to beds now dominated by this pteridophyte.

Conclusion

Cloughton Wyke is a nationally important site for plants fossils of the Cloughton Formation. Within the varied assemblages there are many examples of organ associations that provide evidence for whole-plant reconstructions of the cycad *Nilssonia,* the bennettites *Ptilophyllum* and *Pterophyllum,* the czekanowskia *Solonites,* and the conifers *Elatides* and *Pagiophyllum.* It is also the type locality for 13 species, one of which, *Cycadolepis eriophous,* is known only from here.

References



(Figure 3.46) Stratigraphical section through the Cloughton Formation exposed at Cloughton Wyke. (After Livera and Leeder, 1981.)

Black Shale B	54° 20' 21", 0° 25' 45"
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Equisetum Bed in waterfall	54° 20' 25", 0° 25' 51"
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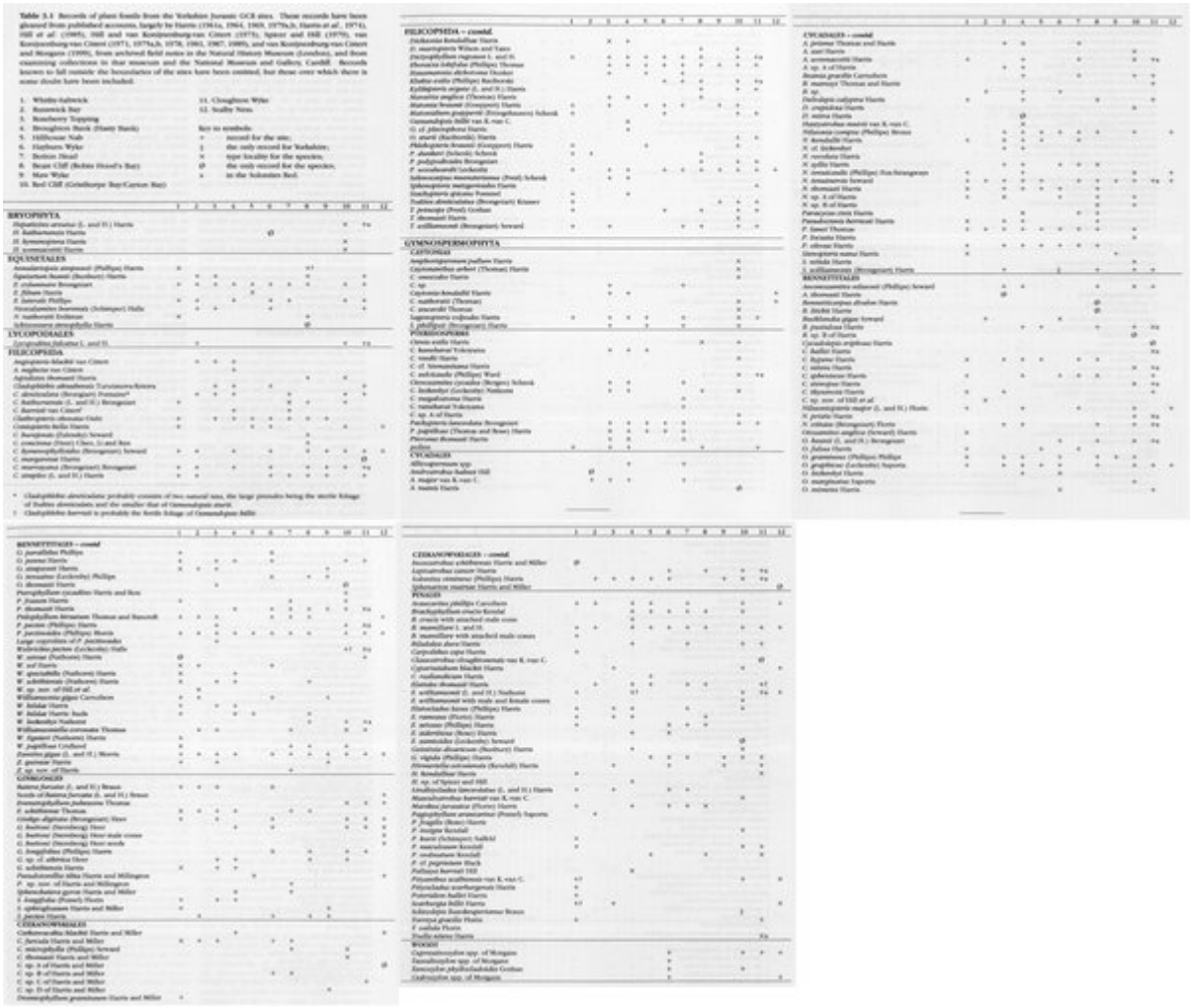

(Table 3.1) Records of plant fossils from the Yorkshire Jurassic GCR sites. These records have been gleaned from published accounts, largely by Harris (1961a, 1964, 1969, 1979a,b; Harris et al., 1974), Hill et al. (1985), Hill and van Konijnenburg-van Cittert (1973), Spicer and Hill (1979), van Konijnenburg-van 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.

(Figure 3.47) Anomozamites nilssonii (Phillips) Harris. These bennettitalean leaves are typically 150 mm by 30 mm and divided into square-cut segments that have minutely dentate ends. Laboratory of Palaeobotany and Palynology, Utrecht, specimen S.3085, Cloughton Formation, Cloughton Wyke, × 1.5. (From van Konijnenburg-van Cittert and Morgans, 1999; photo: J.H.A. van Konijnenburg-van Cittert.)