# Whitby–Saltwick (East Pier–Whitestone Point), Yorkshire

[NZ 901 115]–[NZ 928 104]

## Highlights

The Whitby coast has produced some of the best Upper Lias fossil reptiles in the world. Specimens of more than 10 species of plesiosaur, marine crocodile and ichthyosaur have been found there, some of them unique to Yorkshire.

## Introduction

The Whitby coast section comprises a series of sea cliffs and ledges of Upper Lias mudstones and alum shales which rise from the east of Whitby harbour and extend to Whitestone Point ((Figure 5.6)A,B). The site is of historic interest in being one of the earliest localities in Britain to be exploited for its fossil reptiles. It has produced many important finds of marine crocodiles, ichthyosaurs and plesiosaurs which form part of a distinct marine fauna, and which are similar to those known from the famous localities at Holzmaden in Germany. The cliffs at Whitby are subject to continuing erosion, and the site has produced many good recent finds.

The wave-cut platform and cliffs east of Whitby harbour have been famous for their marine reptiles since the middle of the 18th century. In 1758, Mr Wooller described 'the fossil skeleton of an animal found in the alum rock… buried by the force of the waters of the universal deluge.' In the same year, William Chapman described the same specimen as 'the fossile bones of an allegator', and the figures show that it clearly was a fine specimen of an early crocodile. The first recorded ichthyosaur from the Yorkshire coast was collected in 1819, and another one in 1821 was described by Young (1820). Further crocodiles were collected soon after from the same area in 1824 (Young, 1825; Charlesworth, 1837). Plesiosaur remains had been found by 1822 (Young and Bird, 1822), and the first plesiosaur skeleton was collected before 1842, but described somewhat later (Owen, 1865). Further crocodiles, ichthyosaurs, plesiosaurs and remains of a ?theropod dinosaur have been collected and described since then. The history is reviewed in detail by Benton and Taylor (1984).

## Description

The stratigraphy of the Upper Lias (Toarcian, Early Jurassic; (Figure 5.6)C; see also (Figure 5.7)) of the Yorkshire coast has been described in detail for the sections between Port Mulgrave and Kettleness, Whitby harbour mouth and Whitestone Point, and at Ravenscar (Dean, 1954; Howarth, 1955, 1962, 1973). The general succession at Whitby, summarized by Howarth (*in* Cope *et al.,* 1980a), and with revised nomenclature from Powell (1984), is:

| | Thickness (m) |
|---|---|
| ———unconformity——— | |
| Whitby Mudstone Formation | |
| Alum Shale Member (lower part of *Hildoceras bifrons* Zone) | |
| Cement Shales | 5.8 |
| Main Alum Shales | 15.2 |
| Hard Shales | 6.3 |
| Jet Rock Member (*Harpoceras falciferum* Zone) | |
| *ovatum* Band | 0.25 |
| Bituminous Shales | 23.0 |
| Jet Rock | 7.1 |
| Grey Shales Member (upper and middle parts of *Dactylioceras tenuicostatum* Zone) | 13.3 |
| Cleveland Ironstone Formation (upper part) | 0.6 |

The beds are nearly flat-lying in the sections to the east of Whitby (Figure 5.6). The Jet Rock Member occurs in the seaward portions of the wave-cut platforms at Saltwick Nab and Black Nab just to the east of Saltwick Bay. Behind these, the Bituminous Shales, *ovatum* Band and Hard Shales outcrop on the platform. The Main Alum Shales and Cement Shales occur mainly in the lower part of the cliff, and the upper part consists of the Mid Jurassic rocks above the unconformity. The Main Alum Shales and the Cement Shales were formerly quarried for the manufacture of alum at Saltwick Nab and at Black Nab.

The Jet Rock Member is a sequence of well-cemented, finely-laminated, grey or brown shales. The shales are frequently bituminous, and contain bands of small to large calcareous concretions known as 'doggers', up to 5 m in diameter. The shale unit is 1–3 m thick and the concretion bearing horizons vary between 0.1 and 1.0 m in thickness. Typical ammonites belong to the genera *Harpoceras, Hildaites* and *Eleganticeras* in the lower five metres of the Jet Rock Member and the bivalve *Inoceramus dubius* occurs above (Howarth, 1962; Hemingway, 1974).

The Bituminous Shales, like the Jet Rock, contain soft jet, but this is considerably less abundant. Likewise, there are fewer calcareous concretions. The shales are less well laminated than the Jet Rock and contain less bitumen. The shale units are 3–8 m thick, and there are three or four 0.15 m bands of pyrite-coated concretions. The most common ammonites belong to the genus *Harpoceras* and the bivalve *Inoceramus* also occurs. Fossils are often pyritized (Howarth, 1962; Hemingway, 1974).

The *ovatum* Band consists of a 2 m thick bed with two dominating bands of large sideritic doggers, which weather to a dark reddish brown. The ammonite *Ovaticeras ovatum* occurs commonly and belemnites are found in associated aggregations.

The Hard Shales are a non-bituminous grey shale unit characterized by scattered calcareous concretions. A thin bed of siderite mudstones is present. The typical ammonite is *Dactylioceras commune.*

The Main Alum Shales are a sequence of alternating soft, grey, flaggy shales (0.25–5.00 m thick) and irregular bands containing scattered calcareous concretions and sideritic mudstone horizons. The shales typically weather to distinctive brittle flakes (Hemingway, 1974, p. 176). *Dactylioceras commune* is the typical ammonite in the lower 12 m of the unit, *Peronoceras fibulatum* in the upper 3 m, with the latter form occuring in association with *Hildoceras, Phylloceras, Dactylioceras, Zugodactylites, Pseudolioceras* and *Peronoceras* (Howarth, 1962; Hemingway, 1974).

The Cement Shales (0.25–4 m thick) consist of grey shales which contain the ammonite *Hildoceras bifrons* and species of *Porpoceras, Catacoeloceras* and *Phylloceras.* The bivalves *Nuculana* and *Gresslya* and belemnites, occur abundantly (Howarth, 1962). At Whitby this unit is unconformably overlain by the Dogger Formation (Aalenian, Mid Jurassic).

The reptiles appear to have been obtained from various horizons, but since most of the material has remained unstudied until recently there has been much confusion over the precise provenances. This difficulty has been brought about by a combination of reasons, but principally through poor collection data and contradictory statements by the early authors. Recent changes in the nomenclature of ammonite zones have created further problems. Benton and Taylor (1984) reviewed the provenance of specimens on the basis of early collectors' reports and on a study of the matrix and ammonites associated with specimens, and a clearer picture of the sources for most of the more important specimens has emerged.

The 'allegator' collected in 1758 (BMNH R1088) was originally described as coming from 'the sea-shore, about half a mile from Whitby. The ground that they lay in is what we call alum-rock, a kind of black slate that may be taken up in flakes. The bones were covered five or six feet with water every full sea' (Chapman, 1758, p. 688). Wooller (1758, p. 790) noted that 'this skeleton lay about six yards from the foot of the cliff, which is about sixty yards in perpendicular height' and that the fossil was found 'about 10 or 12 feet deep in… the black slate or alum rock.' Thus, the locality was most probably The Scar, a small promontory in the Alum Shales about 700 m Chaff a mile') east of Whitby harbour mouth [NZ 909 115]. The cliff here is 50–55 m (sixty yards) high, exactly as Wooller (1758) described, and the wave-cut platform is easily accessible from Whitby. Westphal (1962, p. 106), however, contradicted this account and, in following Simpson (1884, p. XI), stated that the skeleton was found in the *Hildoceras serpentinum* Zone (= *H. falciferum* Zone), which occurs 12 m–18

m above the Jet Rock 'Series', therefore in the Bituminous Shales of the Jet Rock Formation. There is some confusion in earlier writings on the Jet Rock 'Series' and the Alum Shales, and where the intervening beds are to be placed, i.e. whether early writers ascribed the Bituminous Shales to the Alum Shales. However, none of the components of the Jet Rock Formation occurs 'half a mile' from Whitby and all the evidence points to an assignment of this crocodile to the Main Alum Shales, contrary to Westphal's statement (Benton and Taylor, 1984).

The crocodile collected in 1824 (WHIMS 770S) was found 'in the face of a steep cliff, not far from the town (Whitby)' (Young, 1825, p. 76), and Westphal (1962, p. 106) stated that it came from an alum pit within the Main Alum Shales. This would restrict the locality to the old alum works at Saltwick Nab [NZ 914 112] or at Black Nab [NZ 921 107].

The specimen named *Steneosaurus brevior* by Blake (*in* Tate and Blake, 1876, pp. 244–6) came from the old 'Zone of *Ammonites serpentinus' (= Hildoceras fakiferum* Zone). This places it in the Jet Rock Formation 'immediately below… the Alum Shale', according to Westphal (1962, p. 106).

The first Yorkshire ichthyosaur to be reported 'was imbedded in the alum-rock, where it is washed by the tide, and covered at high water, about half a mile east from the entrance of Whitby harbour, and ten yards from the face of the steep cliff… . The cliff… is about sixty yards in height… . The skeleton lay in the upper part of the great aluminous bed, which here descends below high-water mark' (Young, 1820, p. 451). This leaves little doubt that the locality and horizon were the same as for the first 'allegator'. A second, more complete, ichthyosaur skeleton was 'found in the compact shale… on the scar' in October, 1821 (Young and Bird, 1828, p. 282). These two specimens apparently came from The Scar [NZ 909 115], the source of the first crocodiles and possibly also from the Main Alum Shales there. The specimens have not been traced, but the figures indicate that they may be examples of *Leptopterygius acutirostris* (Owen, 1840a).

Forty or so specimens of ichthyosaurs were collected from the Whitby area from about 1820 (Young and Bird, 1828, pp. 283–6), but most of these were purchased by private collectors and cannot at present be traced. The bulk of these 'were found at or near Saltwick, in the main bed of the alum shale'. The Scar is mentioned again for some of the specimens, but others may have come from excavations in the alum shale cliff at Saltwick Nab [NZ 914 112].

The first important plesiosaur was found 'by Mr Marshall of Whitby, imbedded in a hard rock belonging to the upper lias beds, situated between Scarborough and Whitby, near the place where that gentleman had formerly discovered the remains of a crocodile' (Dunn, 1831). If the 'crocodile' is WHIMS 770S, this plesiosaur came from the vicinity of Saltwick Bay, and probably from a nodule in the Alum Shale Formation. It was a partial postcranial skeleton, lacking much of the neck, apparently of a large plesiosauroid with a body about 3 m long. The best documented find of a plesiosaur was an almost complete articulated skeleton of a plesiosauroid about 4.5 m long with a 0.2 m long skull (CAMSM J35182). It was referred to the Lower Lias species *Plesiosaurus dolichodeirus,* or alternatively to the Owen MS species *P. grandipennis* (Phillips, 1853), but was renamed by Seeley (1865a, 1865b) who described it as the type of *P. macropterus.* Watson (1911a) redescribed it as the neotype of *Eretmosaurus* Seeley, 1874, a genus that had been erected on the basis of undiagnosable material. It was found in the early summer of 1841 by Matthew Green and two other jet collectors of Whitby in the Lias cliffs at Saltwick (Browne, 1946, p. 57).

All later finds to be described from Whitby can only be localized on the basis of crude zonal data which are the only clues as to the provenance of specimens provided by the later authors. Blake (*in* Tate and Blake, 1876) listed the following reptiles from the 'Zone of *A. communis'* (i.e. Alum Shale Formation): *Plesiosaurus homalospondylus, P. coelospondylus* (from Saltwick Alum Pit; Simpson, 1884, p. 9), *Ichthyosaurus acutirostris* and *I. longirostris.* Blake (*in* Tate and Blake, 1876, pp. 250–2) stated that *'Plesiosaurus' longirostris* came from the 'Zone of *A. serpentinus'* (i.e. Jet Rock Formation). White (1940, p. 452) notes the old zonal assignment of *Macroplata (P.) longirostris,* but mistakenly listed the specimen as coming from near the bottom of the Alum Shale.

A few specimens in collections offer some additional information on the typical occurrence of the Whitby reptiles. A recently collected ichthyosaur in the British Museum (BMNH R8309) carries the label 'Bituminous Shale, Black Nab', and a pair of ichthyosaur jaws collected in 1981 came from below the High Lighthouse [NZ 929 103], most probably from the Bituminous Shales. A second skeleton of *Macroplata iongirostris* was found in 1960 in the *bifrons* Zone 'between Old Peak and Blea Wyke Point, southeast of Robin Hood's Bay' (Broadhurst and Duffy, 1970). This specimen (MANCH

unnumb.) is about 4 m long. A *Steneosaurus* lower jaw (BMNH R12011) was collected in 1989 in the Bituminous Shales just south of Black Nab [NZ 926 104].

In conclusion, the bulk of the reptiles from Whitby appear to have come initially from the Main Alum Shales of The Scar, and later from the alum workings in the cliff at Saltwick Nab and Black Nab. A few specimens appear to have been found in the Jet Rock Formation (?Bituminous Shales), probably on the foreshore between Saltwick Nab and Black Nab.

Taphonomic study of the Whitby marine reptile remains has been hampered by the lack of suitable collection data and in addition by the incompleteness of some specimens, the result of collection failure and through artificial 'improvements' made to certain specimens. An examination of museum specimens shows most skeletons to be well preserved in an articulated state with only slight damage, probably as a result of scavenging. This was presumably minimized by the prevailing anoxic conditions in the bottom sediment, as suggested by their bituminous nature. Other partial skeletons may have been broken up prior to burial or by recent wave action before the specimens were collected from the foreshore.

## Fauna

About 20 species of marine reptile have been described from the Whitby area (Benton and Taylor, 1984), of which seven may be valid, but further revision might alter the figure. Of these seven, four (*Steneosaurus brevior, S. gracilirostris, Rhomaleosaurus longirostris* and *Sthenarosaurus dawkinsi*) occur only at Whitby, and one (*Stenopterygius acutirostris*) probably occurs only in Yorkshire. The taxonomy of the Upper Lias crocodiles from Whitby has been reviewed by Westphal (1961, 1962) and Duffin (1979a, 1979b), the ichthyosaurs by McGowan (1974b, 1976, 1978, 1979), and the plesiosaurs by Watson (1909c, 1910b), White (1940), Persson (1963) and Taylor (1992b). Approximate numbers of specimens in the BMNH, CAMSM, WHIMS and YORYM are given.

| **Sauropterygia: Plesiosauria** | Numbers |
|---|---|
| *Eretmosaurus macropterus* (Seeley, 1865a) | 1 |
| *Macroplata longirostris* (Blake, 1876) Type: MCZ 1033 | 1+ |
| *Microcleidus homalospondylus* (Seeley, 1865) Type: YORYM G502 | 6 |
| *Sthenarosaurus dawkinsi* Watson, 1909 Type: MANCH L8023 | 2 |
| *Thaumatosaurus propinquus* (Blake, 1876) | 2 |
| *'Plesiosaurus'* sp. | 4 |
| **Ichthyopterygia: Ichthyosauridae** | |
| *Stenopterygius acutirostris* (Owen, 1840) Type: BMNH 14553 | 8 |
| *Eurhinosaurus longirostris* (Mantell, 1851) Type: BMNH 14566 | 1 |
| *'Ichthyosaurus'* sp. | 12 |
| **Archosauria: Crocodylia: Thalattosuchia:** Teleosauridae | |
| *Steneosaurus bollensis* (Jaeger, 1828) | 9 |
| *Steneosaurus brevior* Blake, 1876 Type: BMNH 14781 | 6 |
| *Steneosaurus gracilirostris* Westphal, 1961 Type: BMNH 14792 | 4 |
| *Pelagosaurus brongniarti* (Kaup, 1835) (incl. *?Teleosaurus chapmani*) | 8 |
| *Pelagosaurus typus* Brown, 1841 | 1 |
| *Steneosaurus* sp. | 6 |
| **Archosauria: Dinosauria: Saurischia** | 1 |
| ?theropod | |

## Interpretation

The Whitby plesiosaurs divide up into forms with long necks and small skulls, others with relatively large skulls and one with long pointed jaws. They also range in total body length from 2 m to 6 m, and clearly used a range of hunting and feeding strategies. Their principal diet was probably cephalopods and fishes, and the larger species might also have eaten other marine reptiles. Their range of forms indicates four qualitative lineages and they provide the best information on plesiosaur evolution in the Upper Lias. Holzmaden and other German localities have also yielded good specimens of the same age, but these localities lack the variety of forms found at Whitby. At Whitby, there are at least two possible pliosauroids (plesiosaurs with short necks and large skulls), *Macroplata longirostris* which has a gracile snout and the *R. cramptoni–R. zetlandicus–R. propinquus* group with robust snouts ((Figure 5.8)C. There are also two or three plesiosauroids (plesiosaurs with long necks and small heads), namely *Microcleidus macropterus, M. homalospondylus* and *Sthenarosaurus dawkinsi. Macroplata longirostris* was about 5 m long with a head about 0.7 m long. It had a remarkably slender head and elongate rostrum, a character unknown in any other Jurassic plesiosaur. *Microcleidus homalospondylus* is represented by nearly complete skeletons which show an animal about 6 m long with an extremely long neck (2.5 m) and a relatively small skull. It had large paddles and is distinguished by characters of the vertebrae and limb girdles. *Sthenarosaurus dawkinsi* based on a partial skeleton collected at Saltwick, is another long-necked form with strong limbs. It is currently regarded as a plesiosauroid (Brown, 1981, p. 339). *Rhomaleosaurus propinquus* was about 2.5 m long and had a 0.6 m skull — relatively large.

The ichthyosaurs from Whitby are the best Upper has forms from Britain. However, those from Holzmaden, of approximately the same age, are more abundant, better preserved and show greater variety. Some of the ichthyosaurs from Whitby may also occur at Holzmaden, although most of the German specimens belong to different species (McGowan, 1974b, 1989b). The two Whitby ichthyosaur species recognized as valid by McGowan (1974b), *Eurhinosaurus longirostris* and *Stenopterygius acutirostris,* are distinguished largely by the relative proportions of parts of the skull ((Figure 5.8)B. For example, *S. acutirostris* has a larger orbit and nasal opening than *E. longirostris in* relation to the overall skull length. *S. acutirostris is* generally larger than *E. longirostris,* with skull lengths from 0.6 m to 1.50 m comparedwith skull lengths of less than 1 m. *Eurhinosaurus is* a swordfish-like form showing a remarkable disparity in the lengths between the upper and lower jaws, the mandible being only about half the length of the skull (McGowan, 1986, 1989b, 1989c). *Stenopterygius acutirostris* was larger than *Eurhinosaurus,* with a skull up to 1 m long, and had a long pointed snout and large orbit.

The crocodiles from Whitby represent the best Jurassic marine forms in Britain, but the preservation is not as good as in material from localities in Germany, such as Ohmden, Holzmaden, Boll, Holzheim (Baden-Württemberg) and Neumarkt (Oberpfalz). The age of these German sites is similar to that of the Whitby sediments (Posidonienschiefer, Lias epsilon 1, 2, 3, Early Toarcian). *Steneosaurus* ((Figure 5.8)A and *Pelagosaurus* are teleosaurs which differ in size and in certain features of the skull and skeleton. *Steneosaurus* was 2.5–5.0 m long, whereas *Pelagosaurus* was under 1.75 m. *S. brevior* has a shorter snout (64% of skull length) than *S. bollensis* (72%) or *S. gracilirostris (*77%) (Westphal, 1961, 1962). However, Steel (1973) synonymized all three species as *S. bollensis.* In *P. typus* the snout is not sharply demarcated from the skull.

The Early Jurassic teleosaurs were specialized water-dwellers with elongate snouts and numerous teeth that suggest a diet of fish. The hind legs were twice as long as the forelegs and were doubtless powerful organs of propulsion. In general, teleosaurs are found in estuarine, shallow marine sediments, and they probably lived partly on land and fed in brackish and salt water. Teleosaurs had a strong bony armour. The group has a long history, the later forms evolving into several narrow- and broad-snouted forms in the Late Jurassic and Early Cretaceous of Europe in particular. The Early Jurassic remains of Whitby and Baden-Württemberg are the best preserved and most useful for an assessment of the relationships and biology of early marine crocodilians. These Early Jurassic teleosaurs represent the first radiation of crocodilians into the sea, after their origin in the latest Triassic as small terrestrial insectivorous animals.

Huene (1926, pp. 36–71) and Wild (1978b, p. 2) cite an undescribed specimen (WHIMS) of a 'middle sized femur' of a carnivorous theropod dinosaur from Whitby. Huene noted that he had not himself seen the specimen and cited a personal letter from 'Dr (D.M.S.) Watson'. The specimen had the fourth trochanter placed above the midpoint of the

femur. This specimen has not been traced; if it is found, it will be of great interest as the only find of a theropod dinosaur from the Upper Lias of any locality. Indeed, only two other dinosaurs are known from the Upper Lias: the hind limb of the sauropod *Ohmdenosaurus* from Ohmden, near Holzmaden (Wild, 1978b), and a nearly complete skull and skeleton of an early thyreophoran, *Emausaurus,* from Klein-Lemahagen, near Rostock (Haubold, 1990).

Two probable pseudofossils from the Whitby Lias have been interpreted as reptilian: a possible teleosaur egg (YORYM 505; Melmore, 1931) and a supposed group of embryos or juveniles of four plesiosaurs (BMNH R3585; Seeley, 1887a, 1888a, 1888b, 1896). The former is certainly egg-shaped, but it consists of a mudstone and calcite 'core' surrounded by a pyrite skin, and is probably a concretion (Benton and Taylor, 1984, p. 418). The latter was reinterpreted by Thulborn (1982) as infilled *Thalassinoides* burrows surrounding a concretion, whereas Benton and Taylor (1984, pp. 418–19) suggested that the nodule was wholly inorganic in origin (?a septarian concretion). Such calcareous and pyritic mudstone 'doggers' occur abundantly in the Lias, and in the Jet Rock Formation in particular (Howarth, 1962).

### Comparison with other localities

Other comparable Upper Lias localities occurring along the Yorkshire coast that have yielded a similar marine reptile fauna include Saltwick and the old alum quarries at Kettleness [NZ 83 16] and Loftus [NZ 74 20]. Further reptile localities, including Runswick Bay, Robin Hood's Bay, Port Mulgrave, Staithes, Sandsend, Hawsker Bottoms, Boulby and Ravenscar (Old Peak–Blea Wyke Point), have also produced a comparable fauna, although the remains of marine reptiles from these localities are less abundant. The Upper Lias of England is not as rich in marine reptile fossils as the Lower Lias. Various localities in Somerset, Northamptonshire, Leicestershire, Lincolnshire and North Yorkshire have yielded isolated ichthyosaurs, plesiosaurs and steneosaurs (see above). The localities at Blisworth [SP 73 54] and Wellingborough [SP 98 68] are still accessible but most of the other sites are now inaccessible and have little potential for future fords.

The reptile faunas most similar to those from Yorkshire are those recorded from various localities in the Upper Lias of south-west Germany (e.g. Holzmaden, Ohmden, Boll, Banz, Altdorf) and France (e.g. Normandy, Franche-Comté). Most of these sites cannot be compared readily with the Whitby section since the recorded finds are too sparse to constitute a 'fauna'. The exception is Holzmaden, Baden-Württemberg, where the bituminous laminated shales and grey mudstones of the Posidonienschiefer, a subdivision of the Schwarzjura ■ (*tenuicostatum* to *bifrons* Zones of the Early Toarcian; Urlichs 1977), have produced hundreds of specimens. Hauff (1921) noted that the bulk of these came from his subdivisions II 2 to II 13 (middle ■, upper *tenuicostatum* Zone to upper *falciferum* Zone), thus rather older on average than the reptiles from the Yorkshire coast. Hauff (1921) records ten specimens of plesiosaurs, including four almost complete skeletons, about 350 specimens of ichthyosaurs, many of which are relatively complete, about 70 specimens of crocodiles many of which are also complete, and about 10 skeletons and bones of pterosaurs. Thus plesiosaurs and crocodiles are relatively less abundant, and ichthyosaurs are much more common at Holzmaden than around Whitby.

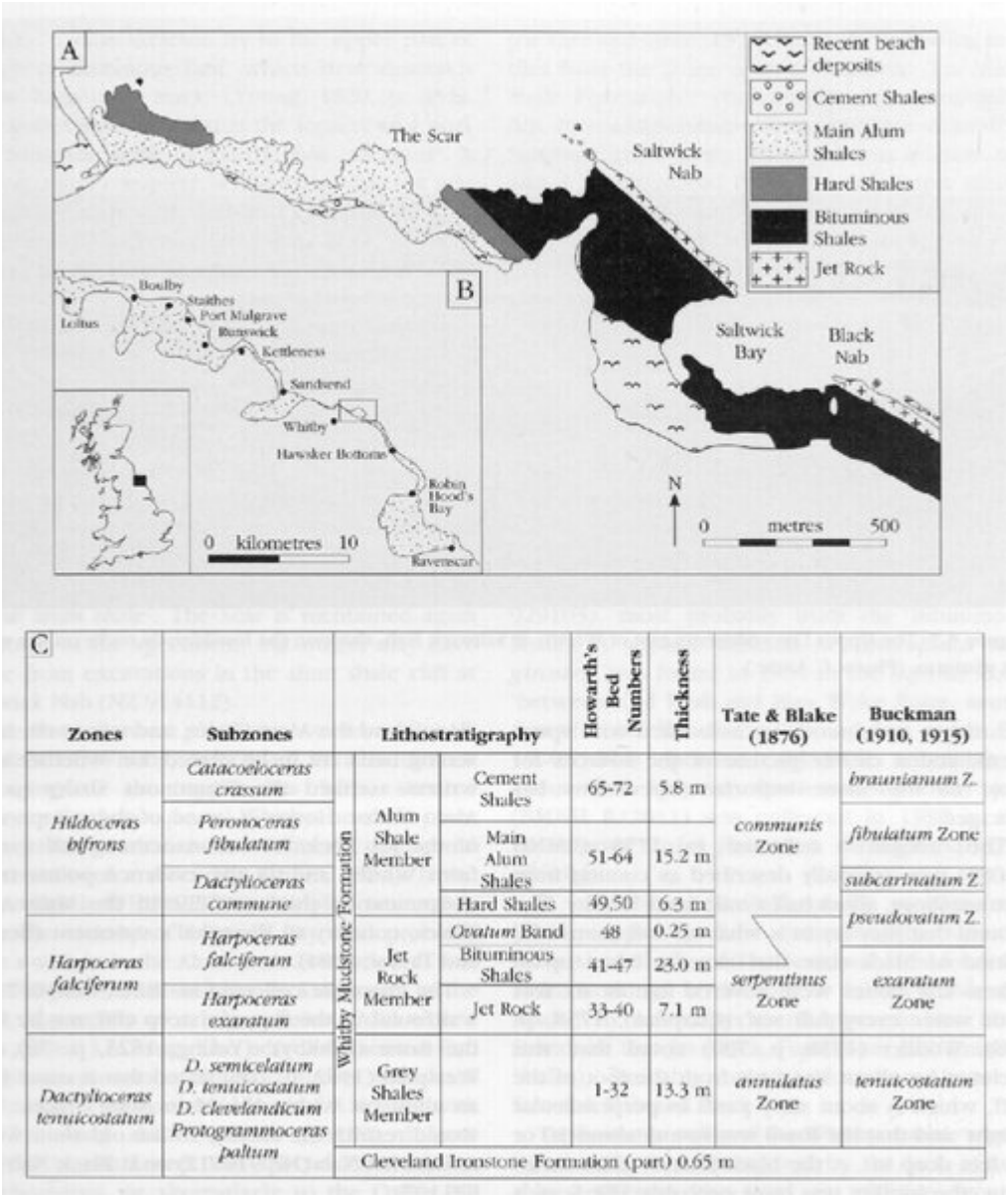
Several species of reptile are shared between Whitby and Germany. Among the crocodiles, *Steneosaurus bollensis, Pelagosaurus brongniarti* and *P. typus* occur in both areas. Among the plesiosaurs, the only Holzmaden pliosauroid is specifically different from the Yorkshire forms, but it is not clear whether any of the plesiosauroids are shared. McGowan (1979) ascribes German *'L. acutirostris'* to *L. burgundiae* (Gaudry, 1892).

## Conclusions

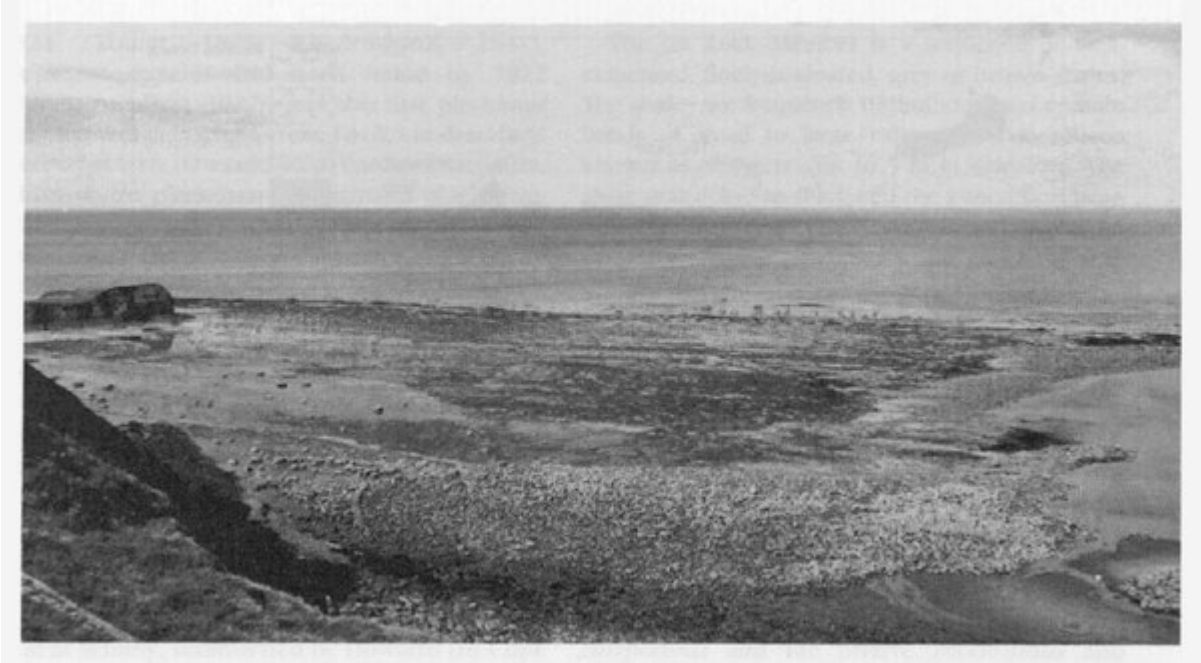
The Yorkshire coast sites are undoubtedly the best for British Upper Lias reptiles. The coast between Whitby and Whitestone Point has yielded more specimens, and type specimens, than any other Upper Lias marine reptile site in Britain, and many of these are articulated. The fauna differs from the Upper Lias faunas of southwest Germany (e.g. Holzmaden) and France. It has produced the best collections of fossil crocodiles from the Early Jurassic of Britain. The ichthyosaurs and plesiosaurs from Whitby are the most numerous and varied of British Upper Lias sites, and the plesiosaurs in particular show a broad range of separate lineages.

The great importance and conservation value of the Whitby–Saltwick section lies, like that of Lyme Regis, in the combination of the richness of historical finds and the potential for future discoveries.

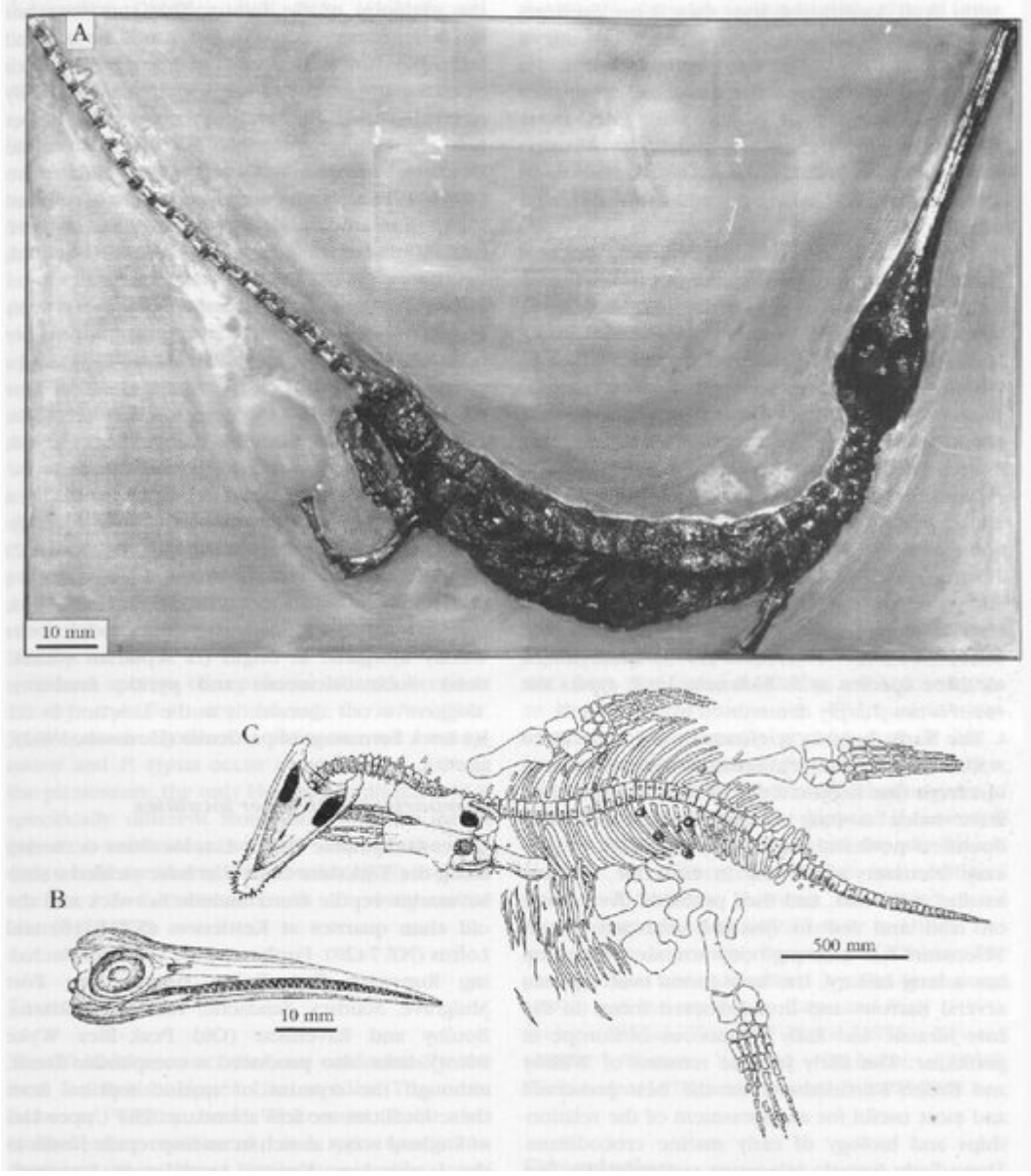
## References




*(Figure 5.6) The reptile-bearing Lower Jurassic (Toarcian) of Whitby. (A) Map of the Upper Lias (Jet Rock Member and Alum Shale Member) exposed on the foreshore between Whitby Harbour and Saltwick Bay. (B) North-east Yorkshire with fossil reptile localities marked. The coastal outcrop of Lias rocks is stippled and the area shown in (A) is outlined. (C) The Lower Toarcian sequence at Whitby, showing ammonite zones and subzones, formations, bed numbers from Howarth (1962), and thicknesses for sections near Whitby (after Cope et al., 1980a). The terminology used by earlier authors is also indicated. From Benton and Taylor (1984), after Howarth (1962).*



*(Figure 5.7) The Upper Lias sediments east of Whitby at Saltwick Nab, showing the fossiliferous rocks on the wave-cut platform. (Photo: C. Little.)*



*(Figure 5.8) Marine reptiles from the Lower Jurassic Alum Shale Member of Whitby. (A) The crocodile Steneosaurus gracilirostris Westphal, 1961, type specimen (BMNH 14792); (B) the ichthyosaur Temnodontosaurus longirostris (Mantel, 1851), type specimen (BMNH 14566); (C) the pliosauroid plesiosaur Rhomaleosaurus cramptoni (Carte and Bally, 1863), type specimen (NMI F8785), skull and skeleton.*