AN EXTENSIVE MARINE VERTEBRATE FAUNA FROM THE KELLAWAYS SAND [CALLOVIAN, MIDDLE JURASSIC] OF LINCOLNSHIRE

by

David S. Brown and John A. Keen

Summary

Vertebrate bones and teeth, hitherto scarce in Kellaways Beds, have been recovered in relative abundance from temporary exposures of the Kellaways Sand east of Lincoln. The fauna includes eleven taxa of sharks including *Lissodus leiodus, Palaeospinax* and a hemiscylliid genus; nine taxa of bony fishes including *Heterolepidotus*; plesiosaurs referable to the families Elasmosauridae [*Muraenosaurus*], Cryptoclididae [*Cryptoclidus*] and Pliosauridae [*Liopleurodon*]; and the marine crocodiles *Metriorhynchus* and *Steneosaurus*. The mostly fragmentary material extends the British and World Callovian faunal list and indicates that some new species may be present. The reptile specimens and some of the fishes occur as associated disarticulated skeletons.

Introduction

The Kellaways beds extend from Dorset through the Midland counties to the Yorkshire coast virtually unseen, since they fail to form exposed topographical features, are of little or no industrial use and therefore not currently quarried. Fossil faunas are sparsely recorded, and only a small number of temporary exposures have yielded vertebrate material.

This paper records the finding and collecting [by John Keen] of a rich vertebrate fauna from temporary exposures in the Kellaways Sand of Lincolnshire. The specimens, except for one plesiosaur skeleton, have been gleaned from residual blocks of sandstone and piles of unconsolidated sand found on the surface after temporary exposures have been filled in. The extensive list of fish and reptilian taxa is compared with that of the Lower Oxford Clay.

The figured specimen (Fig. 2; Plate 1), together with associated remains, have been donated to Scunthorpe Museum (prefix: SCUNM).

Stratigraphy

The Kellaways Formation is a component of the Lower Callovian Substage [English Middle Jurassic], and in Southern England comprises Kellaways Clay and Kellaways Sand Members. In a recent review of English Lower Callovian stratigraphy, Page (1989 p. 368; figs. 4, 10) states that the Kellaways Clay facies progressively thins northwards and is partly replaced through lateral passage into the overlying Kellaways Sand. Thus in the Lincoln area the Formation comprises only the Kellaways Sand Member, perhaps 5 m thick, which rests upon the Cayton Clay Formation [Cornbrash] and is overlain by Lower Oxford Clay.

Typically, the Kellaways Sand consists of yellow or grey sands which may be uncemented or poorly cemented with calcareous sandstone bands, and represents two ammonite zones: *Proplanulites koenigi* and *Sigaloceras calloviense*. There are no natural exposures in the Lincoln area: it lies immediately beneath farmland in a narrow strip striking north-south some 5 or 6 km east of the Lincoln Edge escarpment. In consequence, it is seen only occasionally when it is disturbed by building work or the laying of drainage pipes.

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Arkell (1933, p. 356) noted that a thickness of 25 feet (= 7.62 m) had been proved in the nineteenth century at Sudbrooke, 7 km north east of Lincoln. More recently (Richardson, 1979) a thickness of 6.43 m was proved by a borehole core from Worlaby, South Humberside (43 km north of Lincoln), at which location the Kellaways Sand is divisible into 3 beds: a thin basal bed consisting of a fine argillaceous calcareous sandstone containing grey limestone pebbles; a topmost bed, 0.53 m thick, of medium-grained firmly cemented calcareous sandstone with abundant pyritous patches; and between these a wide bed of fine light grey uncemented quartz sand with carbonaceous and clay patches.

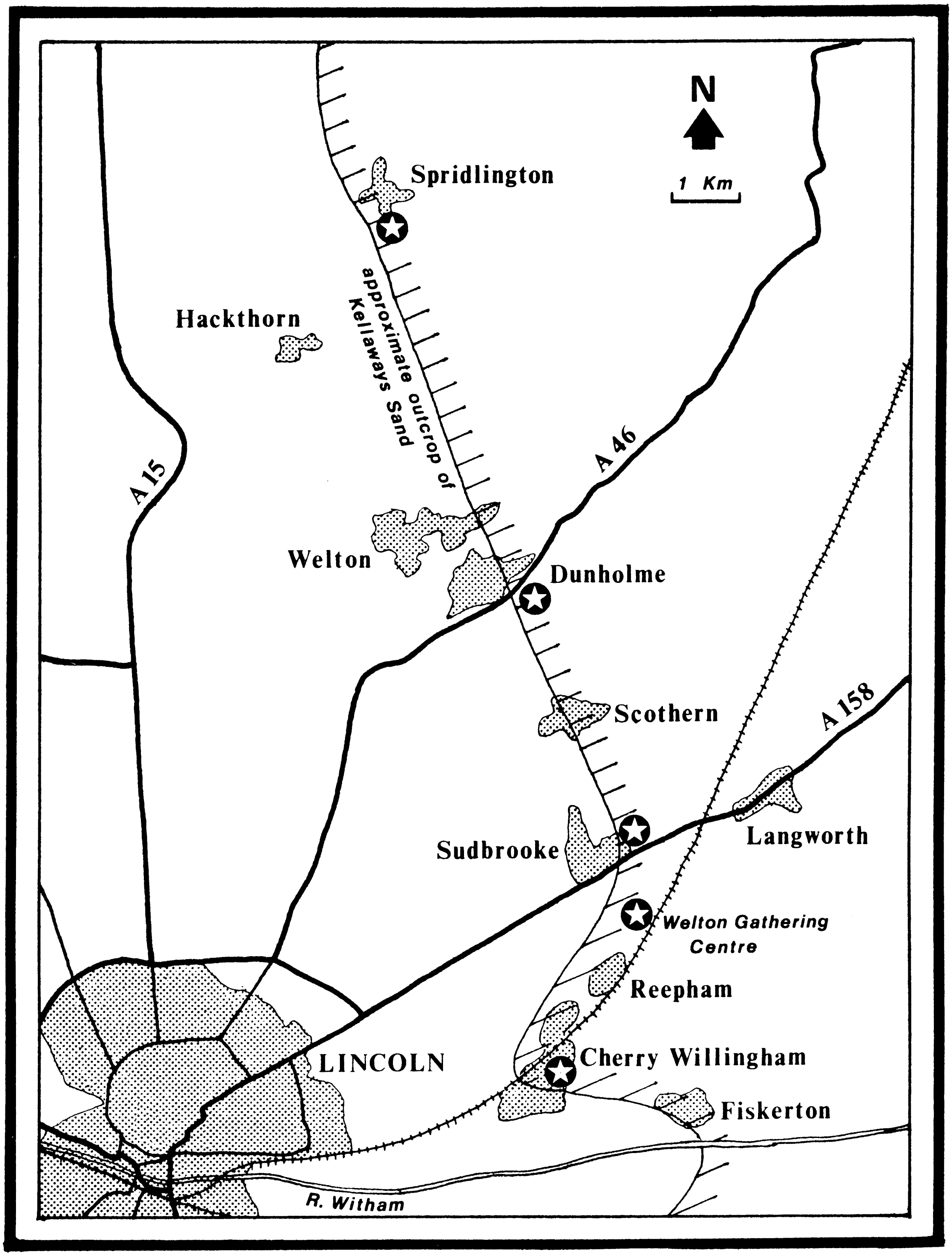

Fig. 1. Sketch-map of the area north-east of Lincoln, showing approximate outcrop of the Kellaways Sand beneath farmland. Stars indicate positions of temporary exposures.

Review of English Kellaways vertebrate fossil record

Finds of vertebrate remains in the Kellaways Beds have hitherto been scarce, and the only records of significance come from North Humberside and Peterborough.

In 1900, Sheppard found plesiosaur bones in a quarry in 'Kellaways Rock' (= Kellaways Sand: Page, 1989) on Mill Hill at Elloughton, near Brough [grid ref. SE 942278 given by Walker, 1972]. Detached bones were recovered and traced back to associated remains of a tail occurring in soft coarse-grained ferruginous sand easily worked by hand. The specimens, which include vertebrae, ribs, paddle-bones and the anterior half of a toothless mandible were referred to the genus *Cryptoclidus* by E.T. Newton of H.M. Geological Survey.

Sheppard (1903 p. 186) noted that just below the remains in Mill Hill Quarry the sand became much finer and whiter. It may be hypothesized, therefore, that if the lithology of the quarry and the Worlaby borehole are comparable then Sheppard's plesiosaur horizon corresponds to the base of the topmost bed seen at Worlaby.

Sheppard subsequently found plesiosaur remains in a 'Kellaways Rock' exposure in Drewton railway cutting, 5 km north of Mill Hill. These and the Mill Hill specimens were given to Hull Museum (Drake and Sheppard, 1909 p. 63), which was destroyed by enemy action during the Second World War.

Further plesiosaur bones, again referred to *Cryptoclidus*, were recorded by Stainforth and Sheppard [1931] from South Cave Station Quarry [to the West of Drewton], together with scales and bones of the halecostome fish *Lepidotes latifrons*. The horizon was not stated, and so may be from below the type section of the overlying Cave Rock Member exposed in this quarry (Page, 1989) and therefore Kellaways Sand.

Martill (1986), discussing the stratigraphic distribution of Callovian vertebrates, noted that macro-vertebrate remains occur frequently in Kellaways Sand of Cambridgeshire and Lincolnshire, usually as isolated worn bones encrusted with epibionts; this material is mostly sauropterygian but some ichthyosaur material is known. His information was based on undescribed fragmentary remains mostly taken from drainage ditches in the floors of brick-pits in the overlying Lower Oxford Clay.

Martill (1988) also drew attention to a sauroped dinosaur from this horizon. The specimen (B.M.N.H. R. 1985–8) consists of a pelvis, ribs and part of a dorsal vertebra which Seeley (1889) described under the name *Ornithopsis leedsi* Hulke, 1887. It was collected by Alfred N. Leeds from a well-shaft sunk at the Peterborough Gas Works: four further dorsal vertebrae described with the specimen by some authors probably are not associated (Leeds, 1956: p. 35). Seeley recorded that the shaft passed through 24 feet of grey clay recognised by Leeds as Oxford Clay and well known to him from nearby brick pits. Below this the shaft passed through 12 feet of sand, mostly light grey in colour, before again reaching a grey clay; and the dinosaur specimen came from 36 feet down, at the junction of the sand and lowermost clay bed. The grey sand can only have been the Kellaways Sand with, underlying it, either a silty clay band within the Kellaways Sand Member or the top of the underlying Cayton Clay Formation [see Page, 1989].

Discovery and extraction of specimens

The finding around Lincoln of detached Kellaways vertebrate fossils, and the search for their origin, began on 7th April 1985 with the discovery of a block of cemented ferruginous sandstone containing a plesiosaur mandible, tooth and phalanges on a tip of rock and other building site rubble in Lincoln. A close search produced further plesiosaur bones; a crocodile tooth; and fish bones, scales and teeth representing about 15 genera.

The sandstone matrix and the specific presence of the oyster *Gryphaea bilobata* amongst the invertebrate fossils indicated the Kellaways beds; and so, with the aid of a geological map, a systematic search for the building site was made along the narrow area of supposed Kellaways outcrop beneath farmland. Three weeks later this site was found 1 km north-east of Reepham (grid ref. TF 04597474), where British Petroleum had almost completed several small buildings and equipment installations comprising the company's Welton Gathering Centre. The foundation trench for a final building was seen cutting into the underlying Kellaways Beds, and upon entering this trench the associated bones of a plesiosaur specimen were discovered exposed on the outer side. This specimen was later collected and removed to Scunthorpe Museum in numerous blocks of the sandstone. It was established that some of the rock and overburden from the site had been dumped at the tip in Lincoln from which the mandible and other specimens had earlier been removed.

Top soil and drift to a depth of about 1 m had been cleared from the area prior to building, and the trench section then showed about 0.5 m of unconsolidated yellow sand beneath which was a band of cemented grey sandstone rock about 1 m thick, with an unconsolidated grey sand beneath. The associated plesiosaur bones occurred about the middle of the rock band.

Two poorly-preserved ammonites (SCUNM.P2908, P2894) taken from the rock with the plesiosaur skeleton have been identified tentatively by Mr. Simon Knell of Scunthorpe Museum as *Sigaloceras enodatum*; this indicates that the horizon is probably *S. calloviense* zone, *S. enodatum* subzone.

Further vertebrate specimens were recovered from elsewhere in the rock and also from the overlying and underlying sand. Several bones and teeth were recovered from rock fragments and sand around the periphery of the Gathering Centre site. Some Reepham rock dumped at Langworth yielded a few fish fragments.

Following the 1985 Reepham discoveries a close watch was kept along the approximate outcrop of the Kellaways Sand in the area. Pieces of the consolidated sandstone and adjacent piles of loose sand, seen after the filling-in of minor temporary exposures such as the laying of a drainage pipe, have yielded further fragmentary vertebrate remains at Cherry Willingham, Sudbrooke, beside the Dunholme by-pass and at Spridlington (see Fig. 1).

The plesiosaur bones were prepared from the matrix, in the Universities of London and Newcastle upon Tyne, using the standard acetic acid technique. This allowed the principal specimen (SCUNM.P2889) to be identified as *Cryptoclidus eurymerus* (Phillips), type-genus and species of the family Cryptoclididae. Somewhat to our surprise, it was discovered that the mandible does not belong with P.2889 and is identified as the elasmosaurid plesiosaur *Muraensaurus leedsii* Seeley (SCUNM. P2916).

Vertebrate material and preservation

1. *Cryptoclidus*

The *Cryptoclidus eurymerus* specimen P.2889 comprises one disarticulated skull bone tentatively identified as the left postorbital; several detached teeth; most of the neck including at least 26 of the 32 centra which should be present (Brown, 1981); less than half of the dorsal and sacral vertebrae; 8 out of a total of about 25 caudal vertebrae; an incomplete pectoral girdle; the left femur; and numerous ribs, gastralia and phalanges.

The bones are clearly the associated remains of a single individual, and some of the vertebrae were preserved in articulated rows of 3 or 4. Mostly, however, the skeleton was disarticulated: a block containing the semi-articulated anterior half of the neck also included the postorbital; some teeth; some dorsal vertebrae; and 4 anterior caudal vertebrae which were again semi-articulated. This would indicate that the carcass had undergone extensive post-mortem decay and mutilation by scavengers before burial. Some ribs were solid and easily prepared from the matrix for most of their length, but were crumbling and incomplete at one end, suggesting that this end had undergone weathering on the sea floor following decomposition of the soft tissue.

The vertebral neural arches are free from the centra indicating that the specimen is a 'juvenile' (Brown, 1981: p. 255).

Characters diagnostic of *Cryptoclidus* are found in the vertebrae, the clavicle and especially the teeth. *Cryptoclidus* has a unique tooth ornament, with long mesial and distal axial ridges extending the full length of the tooth; only 3 to 5 lingual ridges and no buccal ridges (Fig. 2).

2. *Muraenosaurus*

The mandible of *Muraenosaurus leedsii* (P. 2916: Plate 1) consists of the dentary: small fragments of a splenial may be fused to its medial aspects, but the remaining elements have separated post-mortem and were not found. There are sockets for 19 teeth on each ramus, and some contain the crowns of immature (replacement) teeth. Brown (1981) gave 19 to 22 dentary teeth as the normal range in this species.

Preserved in the same block with the mandible was a large mature tooth (Fig. 2), with a ridge ornament typical of elasmosaurs and thereby differing considerably from that of *Cryptoclidus*.

Finally the block contained 4 metacarpals which were of the correct size order to have been from the same specimen; phalanges, however, are not diagnostic even at family level, and this occurrence with the mandible is open to alternative interpretation.

Isolated vertebrae referable to *M. leedsii* were collected from the same tip site; they may once have belonged with this specimen.

3. **Other reptiles**

Two crocodiles and a pliosaur are represented by detached teeth recovered from the Welton Gathering Centre and Dunholme sites. A few additional crocodile and plesiosaur vertebrae of indeterminate affinity are present in the collection.

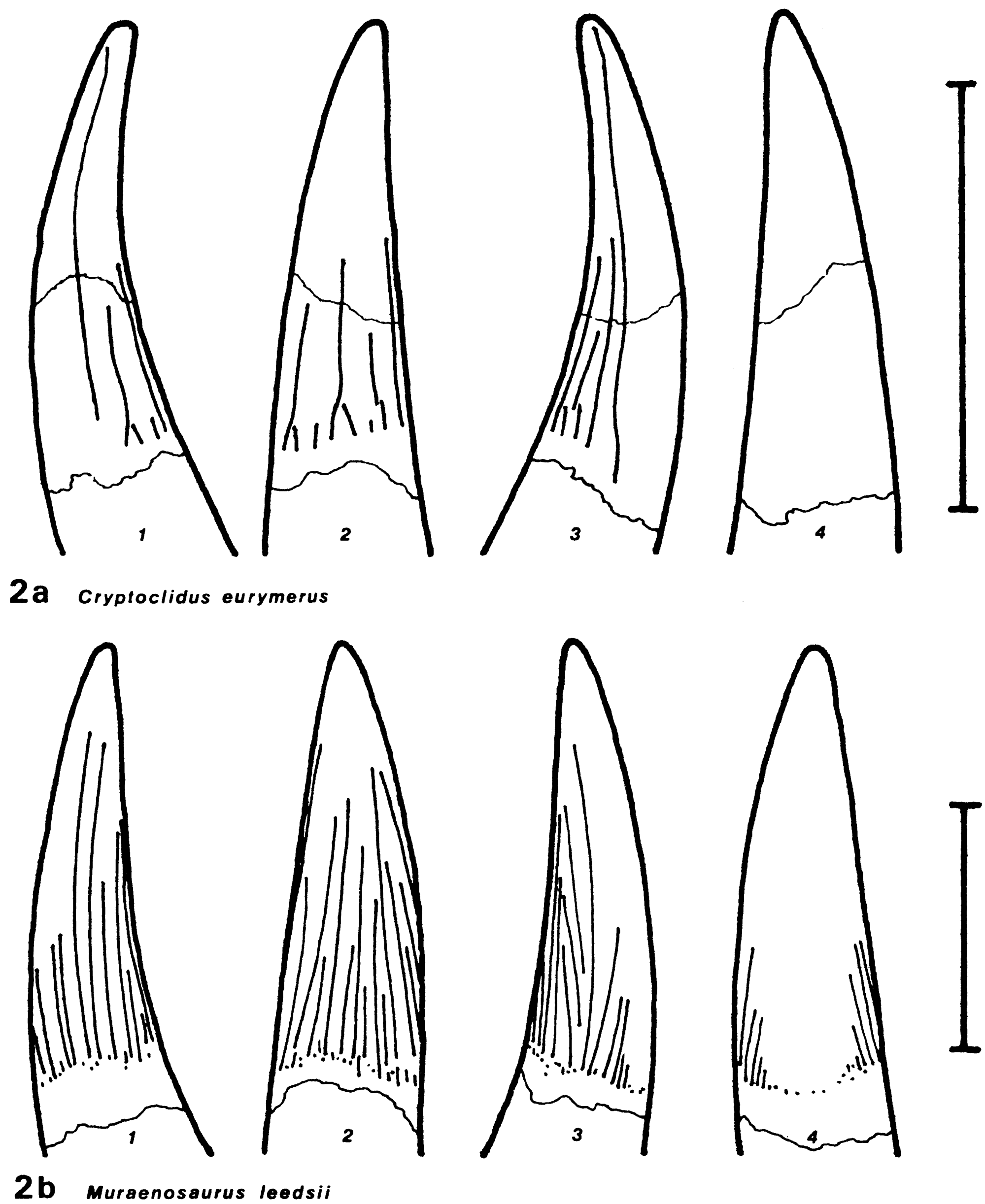

Fig. 2. Detached teeth [a] of *Cryptoclidus eurymerus* [SCUNM.P2889] and [b] of *Muraenosaurus leedsii* [SCUNM.P2916], showing pattern of ornamental ridges: 1 and 3: axial [mesial/distal]; 2: lingual, and 4: buccal aspects. Scale-line = 1 cm.

4. **Fishes**

Some of the fish remains are preserved as associated disarticulated specimens. A block of sandstone from Welton Gathering Centre, Reepham (found on the tip in Lincoln), contains associated skull bones, vertebrae and fin elements of the halecomorph fish *Osteorachis*. The *Heterolepidotus* material [a jaw and scales] is associated; and similarly a teleost genus, *Aspidorhynchus*, is represented by associated teeth, a jaw, scales and bones from both Reepham and the Dunholme site.

Typically, however, the fish fauna is represented by dissociated teeth and fin spines (Chondrichthyes) or by teeth, bones or isolated scales (Osteichthyes). Amongst the shark material the hybodontid species *Lissodus leiodus* and an unidentified hemiscyllid genus are rare taxa, each represented by a tooth; and an orectolobid taxon, again represented by a tooth, may be a new species (Miss A.L. Longbottom, pers. comm.). Two bones have been identified provisionally as gillrakers of the world's largest-ever fish *Leedsichthys*, although the resemblance is not exact (Dr. C. Patterson, pers. comm.).

Vertebrate faunal list

CHONDRICHTHYES	
Elasmobranchii	
Hybodontiformes	
Hybodontidae	
Acrodus sp.	Teeth
Hybodus sp.	Tooth, finspine
? *Asteracanthus* [=*Strophodus*] sp.	Tooth, finspine
Lissodus leiodus	Tooth, finspine
Neoselachii	
Incertae sedis	
Palaeospinax sp.	Tooth
Sphenodus sp.	Tooth, jaw
Squalomorphii	
Hexanchidae	
Gen. indet.	Tooth
Galeomorphii	
Orectolobidae	
Gen. indet. [= ? Gen. nov.]	Tooth
Hemiscylliidae	
Gen. indet.	Tooth
Holocephali	
Chimaeroidei	
Incertae familiae	
Ganodus [=*Leptacanthus*] *semistriatus*	Finspine
Edaphodontidae	
Ischyodus egertoni	Tooth

OSTEICHTHYES	
Actinopterygii	
Halecostomi	
Incertae sedis	
Semionotidae	
Lepidotes sp.	Scales, tooth
Dapediidae	
Heterostrophus sp.	Skull bones
Halecomorphi	
Caturidae	
Caturus [=*Strobilodus*]	Jaw
Osteorachis sp.	Associated bones
Heterolepidotus sp.	Associated scales, jaw
Teleostei	
Pachycormidae	
Gen. indet.	Tooth
Leedsichthys sp.	? Gillrakers
Aspidorhynchidae	
Aspidorhynchus sp.	Associated scales, bones, jaw
Leptolepidae	
Gen. indet.	Dentary
REPTILIA	
Archosauria	
Crocodylia	
Teleosauridae	
Steneosaurus sp.	Tooth
Metriorhynchidae	
Metriorhynchus sp.	Tooth
Sauropterygia	
Plesiosauria	
Elasmosauridae	
Muraenosaurus leedsii	Jaw, teeth, bones
Cryptoclidae	
Cryptoclidus eurymerus	Associated skeleton
Pliosauridae	
Liopleurodon ferox	Tooth

Classification of Elasmobranchii after Thies and Reif, 1985; holocephalans after Ward and Duffin, 1989; osteichthyans based upon Schaeffer and Patterson 1984; crocodiles after Steel 1973; plesiosaurs after Brown 1981.

Discussion

The vertebrate fossil material described above has been recovered from a few relatively small temporary exposures. Nevertheless, the faunal list, especially for the fishes, is extensive and diverse.

Comparable assemblage

The closest comparable vertebrate assemblage, with regard to horizon and geography, is that of the Lower Oxford Clay of the Peterborough area, 80 km to the south of Lincoln and immediately overlying the Kellaways Sand. Here the clay has been quarried extensively for brick manufacture since at least the mid-nineteenth century; and its vertebrate fauna is one of the best-known Mesozoic marine assemblages in Europe as a result of extensive research on specimens in the Leeds Collection.

By the beginning of the twentieth century Alfred N. Leeds had amassed from the brick pits the largest private collection of vertebrate fossils in Britain. Most of this collection is now in The Natural History Museum, London, where the reptiles were catalogued by Charles Andrews (1910–1913).

Current faunal list

In 1910 (p. viii), Andrews published a faunal list for the Leeds Collection, which was reproduced without change by Woodward in Arkell (1933: p. 358). This list was updated and incorporated into a compilation of data on the world distribution of Jurassic fishes by Schaeffer and Patterson (1984: Table 3, marine fishes; Table 4, non-marine fishes); their Tables permit the extraction of lists of recorded fish genera from the Callovian of Britain and the rest of the world. An up-to-date faunal list for the British Oxford Clay (Upper Callovian—Upper Oxfordian) has been given very recently by Martill and Hudson (1991). There are no previously published vertebrate faunal lists for the Kellaways Formation.

Elasmobranchii

Our list of elasmobranch sharks, with 9 genera (including indeterminate genera), compares with only 2 (*Asteracanthus, Hybodus*) on Andrew's list from the Leeds Collection. Martill and Hudson show 10 genera from the Oxford Clay, and their list does not include *Acrodus, Palaeospinax, Lissodus* or any hemiscylliid genera.

The genus *Acrodus* is shown by Schaeffer and Patterson from the British Sinemurian, Bajocian and Bathonian, with worldwide no previous Callovian records. Our record thus extends the British Jurassic range. *Acrodus* is known, however, from as high as the Lower Campanian, Upper Cretaceous [Capetta, 1987].

Similarly, the British Jurassic range of the genus *Palaeospinax* is extended upwards from the Sinemurian. Teeth of *P. riefgrafi* were described from the Oxfordian of Germany by Thies (1983): this constitutes the only reliable previous record of the genus outside the Lias, a report from the Upper Cretaceous of Canada having been rejected by Cappetta [1987] as impossible to establish.

The genus *Lissodus* was reviewed by Duffin (1985), who determined that the range of attributable species extends from the Lower Carboniferous to the Upper Cretaceous. *L. leiodus* is known only from 21 teeth from the English Bathonian and a further 5 from the ?Bajocian of Brora, N. Scotland. Our record thus constitutes the first Callovian record of this rare species and extends its range.

Lissodus is listed by Schaeffer and Patterson only as a non-marine genus; Duffin, however, concluded that it was primarily marine, but with some Triassic and Cretaceous species secondarily invading freshwater. *L. leiodus* he regards as a marine species, pointing out that most of the British Great Oolite (though lacking ammonites) is demonstrably marine and comprises carbonate bank deposits containing abundant echinoid and other marine invertebrates. Thus the finding of this species for the first time in an ammonite-bearing deposit does not appear to pose any palaeoecological questions. The possibility that the teeth have been reworked cannot be discounted.

The range of the galeomorph family Hemiscylliidae is given by Cappetta (1987) as Cenomanian [Upper Cretaceous] to Recent, and so our record of an unidentified hemiscylliid genus from the Callovian would appear to extend the family range. However, we are informed by Dr. C. J. Duffin [personal communication] that teeth from the Toarcian of Germany described and figured by Thies (1983: p. 28; Pl. 6 fig. 4; Pl. 7 figs 1–8) as *Heterodontus duffini* n.sp. are also hemiscylliid. Ours is thus the first Callovian and first British Jurassic record of the family.

Holocephali

Andrews listed 3 genera of chimaeroid holocephalans from the Leeds Collection [*Ischyodus, Pachymylus* and *Brachymylus*], of which we have found only *Ischyodus*. The genus *Leptacanthus* was reported from Bajocian, Bathonian, Kimmeridgian and Portlandian Stages by Schaeffer and Patterson [1984] and is listed from the Oxford Clay [without qualification of horizon] by Martill and Hudson [1991].

Osteichthyes

Of interest amongst the osteichthyan fishes on our list is the halecomorph *Heterolepidotus*. This record fills a gap in the known range of the genus, being the first material to be reported from the World Callovian. Schaeffer and Patterson (1984) gave the British range as Hettangian to Sinemurian, with additional records only from the Toarcian and Kimmeridgian of Northern Europe.

Comparison with Leeds Collection fauna

Comparing the fish faunas of the Leeds Collection [Lower Oxford Clay] and our study of Kellaways Sand in Lincolnshire, the diversity is broadly similar: Andrews listed a total of 14 genera and 19 species; we list 20 genera with 5 being indeterminate. There are, however, apparent differences in the balance of major groups: our fauna is dominated by elasmobranch sharks, whereas the Leeds Collection is dominated by the 'ganoid' halecostome fishes. These differences may in part be taphonomic, and they also reflect fossil size and collector enthusiasm: Leeds largely overlooked the very small neoselachian teeth; they are nevertheless present in the Oxford Clay, as shown by Thies [1983] in his micropalaeontological study.

The reptilian material is less easy to compare and assess, since most isolated bones such as vertebral components, phalanges, and ribs, are non-diagnostic or determinable only at ordinal or even subclass level. In general, a substantially associated skeleton or skull is required to distinguish genera and species. One also needs a large net to catch large animals; and so their diversity within the fossil assemblage is likely to be understated, in comparison with the smaller and more readily distinguishable fishes, when relying on erratic small-scale sampling.

The positive identification of 5 genera, representative of 5 families [all of which occur in the Leeds Collection: Andrews, 1910], is based on teeth; a single *Muraenosaurus* mandible; and the associated *Cryptoclidus* skeleton which, significantly, was the only specimen recovered *in situ*. The Leeds Collection contains a large number of such skeletons, and Andrews' list of 19 genera reflects the large-scale sampling which was available to the collector. The clay quarries were worked by hand, and the quarrymen summoned Leeds and worked elsewhere so as to enable him to collect skeletons when they were found [Leeds, 1956].

The Lower Oxford Clay is about 12 m thick in the Peterborough area, vertebrate fossils being more abundant in the basal 1 m thick section comprising the zone of *Kosmoceras jason* (Martill, 1986). Even this zone cannot be described as vertebrate fossil-rich, and has only yielded so much material because of large-scale quarrying extended over a long period of time. In contrast, it would appear from the comparable fauna list and small scale of sampling that the fossiliferous upper part of the Kellaways Sand [2 m seen at Reepham to be vertebrate-bearing] is very much richer in vertebrate fossils.

Comments

This is not a chance finding of an isolated rich lens, since the distribution of sites of recovery of specimens covers a distance of 12 km along the outcrop (Fig. 1), indicating that the Kellaways Sand is rich in vertebrates over this area.

The importance of the discovery which we describe lies not so much in the scientific value of any individual fragmentary specimen but more in the implication that the bed in question is exceptionally rich, laterally extensive, palaeontologically very promising and, in theory, would be easily accessible for future systematic exploration as it lies only a few metres below farmland.

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British Petroleum generously provided financial assistance towards materials to prepare the *Cryptoclidus* skeleton; most of the work was undertaken in the Geology Department of Queen Mary College, University of London, by Phillip Jones, Christopher Mole and Archie McLaughlan. Dennis Parsons and David Elford assisted with the collection of the specimen.

Reptilian material was seen by Dr. Angela Milner, and fish remains were identified by Dr. Colin Patterson and Miss Alison Longbottom of The Natural History Museum, London.

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References

Andrews, C.W., 1910–13. *A descriptive catalogue of the marine reptiles of the Oxford Clay*. Vol. 1, 205pp., 10pls. [1910]. Vol. 2, 206pp., 13pls. [1913]. British Museum (Natural History), London.

Arkell, W.J., 1933. *The Jurassic System in Great Britain*. xii + 681pp. Clarendon Press, Oxford.

Brown, D.S., 1981. The English Upper Jurassic Plesiosauroidea [Reptilia] and a review of the phylogeny and classification of the Plesiosauria. *Bull. Br. Mus. Nat. Hist.* (Geol.) 35 [4]: 253–347.

Cappetta, H., 1987. Chondrichthyes II. Mesozoic and Caenozoic Elasmobranchii. In Schultze, H.-P. [ed]: *Handbook of Paleoichthyology*. Vol. 3B, 193pp. Gustav Fischer Verlag, Stuttgart + New York.

Drake, H.C. and Sheppard, T., 1909. Classified list of organic remains from the rocks of the East Riding of Yorkshire. *Proc. Yorks. Geol. Soc.* 17 [1], 4–71.

Duffin, C.J., 1985. Revision of the hybodont selachian genus *Lissodus* Brough (1935). *Palaeontographica* Abt.A 188, 105–152.

Hulke, J.W., 1887. Note on some dinosaurian remains in the collection of A. Leeds Esq., of Eybury, Northamptonshire. *Quart. J. Geol. Soc. Lond.* 42, 695–702.

Leeds, E.T., 1956. *The Leeds Collection of fossil reptiles from the Oxford Clay of Peterborough*. 104pp. Blackwell, Oxford.

Martill, D.M., 1986. The stratigraphic distribution and preservation of fossil vertebrates in the Oxford Clay of England. *Mercian Geol.* 10 [3], 161–186.

Martill, D.M., 1988. A review of the terrestrial fauna of the Oxford Clay. *Merican Geol.* 11 [3], 171–190.

Martill, D.M. and Hudson, J.D., 1991. *Fossils of the Oxford Clay*. London: Palaeontological Association [Field guides to fossils series]. [In press].

Page, K.N., 1989. A stratigraphical revision for the English Lower Callovian. *Proc. Geol. Ass.* 100 [3], 363–382.

Richardson, G., 1979. The Mesozoic stratigraphy of two boreholes near Worlaby, Humberside. *Bull. Geol. Surv. G.B.*, No. 58.

Schaeffer, B. and Patterson, C., 1984. Jurassic fishes from the Western United States, with comments on Jurassic fish distribution. *Am. Mus. Novitates* No. 2796, pp. 1–86.

Seeley, H.G., 1889. Notes on the pelvis of *Ornithopsis*. *Quart. J. Geol. Soc. Lond.* 45, 391–397.

Sheppard, T., 1900. Notes on some remains of *Cryptocleidus* from the Kellaways Rock of East Yorkshire. *Geol. Mag.*, n.s. [4] 7, 535–538.

Sheppard, T., 1903. *Geological rambles in East Yorkshire*. xi + 235pp. A. Brown & Sons, London.

Stainforth, R.M. and Sheppard, T., 1931. Recent finds in the Kellaways Rock at South Cave, Yorks. *Naturalist*, March 1931 p. 87.

Steel, R., 1973. Teil 16: Crocodylia. In: *Handbuch der Paläoherpetologie*. vii + 116pp. Gustav Fischer Verlag, Stuttgart + Portland, U.S.A..

Thies, D., 1983. Jurazeitliche Neoselachier aus Deutschland und S-England. *Cour. Forsch.-Inst. Senckenberg* 58, 1–117.

Thies, D. and Reif, W.-E., 1985. Phylogeny and evolutionary ecology of Mesozoic Neoselachii. *N. Jb. Geol. Paläont. Abh.* 169 [3], 333–361.

Walker, K.G., 1972. The stratigraphy and bivalve fauna of the Kellaways Beds [Callovian] around South Cave and Newbald, E. Yorkshire. *Proc. Yorks. Geol. Soc.*, 39, 107–138.

Ward, D.J. and Duffin, C.J., 1989. Mesozoic Chimaeroids I. A new chimaeroid from the Early Jurassic of Gloucestershire, England. *Mesozoic Res.* 2 [2], 45–51.

David S. Brown,
Department of Oral Biology,
The Dental School,
University of Newcastle upon Tyne,
Framlington Place,
Newcastle upon Tyne,
NE2 4BW.

John A. Keen,
44 Laburnum Drive,
Cherry Willingham,
Lincoln,
LN3 4AS.

Plate 1. Dentary [dorsal aspect] and detached tooth of *Muraenosaurus leedsii*, from the Kellaways Sand of Welton Gathering Centre, Reepham, Lincolnshire.