Kimmeridge Bay (Gaulter Gap–Broad Bench)

[SY 898 789]–[SY 908 787] (Potential GCR site)

Highlights

The cliff sections between Gaulter Gap and Broad Bench include the most famous fossil fish sites of Kimmeridge Bay in Dorset, which continue to produce many good specimens of Late Jurassic fishes on a regular basis.

Introduction

The Kimmeridge Clay of Kimmeridge Bay, is world famous for its marine vertebrates (Benton and Spencer, 1995). The cliffs and foreshore reefs of the bay (Figure 12.22) are subject to continuing erosion, and several finds have been made in recent years. They have potential for future discoveries. The geology of the site has been recorded by many authors, but in most detail by Cope (1967; *in* Torrens, 1969a; *in* Cope *et al.,* 1980b).

Description

The Kimmeridge Clay in Kimmeridge Bay is a 138 m sequence of grey to dark grey-blue ammonite-bearing mudstones and shales with sporadic cementstone (limestone/dolostone) bands. The dominant argillaceous units comprise alternations of homogeneous and locally blocky mudstones and finely laminated, fissile bituminous shales. Mudstone units appear to be structureless, but after weathering some mottling may be seen. The base of the mudstone units weathers out more sharply than the upper sections and the upper boundaries appear to be transitional to the bituminous shales. These are rather thinner than the mudstone units, from between 0.1 and 0.4 m thick, the mudstones measuring 0.1 m to about 1 m. Erosion of the mudstones and shales is rapid, but the cement-stone bands stand out.

At Kimmeridge Bay, the beds dip south-east (Figure 12.22) and there are several faults. The general sequence, based on Cope (1967; *in* Torrens, 1969a; *in* Cope *et al.,* 1980b) is:

	Thickness (m)
Late Kimmeridgian (formerly Mid-Kimmeridgian)	
wheatleyensis Zone	
Grey Ledge Stone Band	0.7
scitulus Zone	
Upper Cattle Ledge Shales	10.8
Cattle Ledge Stone Band	0.5
Lower Cattle Ledge Shales	15.0
Yellow Ledge Stone Band	0.4
Total	27.4
elegans Zone	
Hen Cliff Shales	21.5
Double band of cementstone with shale intercalation	1.1
Total	22.6
Lower Kimmeridgian	
autissiodorensis Zone	
Maple Ledge Shales	22.5
Maple Ledge Stone Band	0.3
Gaulter's Gap Shales	32.0
Washing Ledge Stone Band	0.35
Washing Ledge Shales (upper part)	8.0

Total	63.15
eudoxus Zone	
Washing Ledge Shales (lower part)	5.0
The Flats Stone Band	0.5
Shales	3.0
Nannocardioceras Bed	0.02
Shales	1.0
Shales	seen to15.0
Total	24.52

The *Aulacostephanus eudoxus* and *A. autissiodorensis* Zones are exposed between Broad Ledge and Maple Ledge. Named stone bands reach shore level as follows: The Flats at Broad Bench [SY 897 787] and at The Flats [SY 905 792]; Washing Ledge [SY 907 791]; Maple Ledge [SY 909 789]. Hen Cliff, between Cavell Tower and Cuddle, exposes the *elegans, scitulus* and *wheatleyensis* Zones (the *Pectinatites* Zones). The stone marker bands include the Yellow Ledge, which reaches the shore at Yellow Ledge [SY 912 782], and the Cattle Ledge and the Grey Ledge higher in the cliff.

The fauna of the Kimmeridge Clay is restricted to the mudstones and bituminous shale units and in both units is essentially the same, being dominated by infaunal bivalves, including *Lucina* and *Protocardia.* There is also an encrusting epifauna, but this is restricted, consisting only of oysters (*Liostrea* and *Nanogyra*). Minor elements include *Discina, Lingula,* '*Gervillia*',*Entolium* and aporrhaid gastropods. The other biofabrics in the mudstones are different from those in the bituminous shales, indicat ing different taphonomies (Aigner, 1980). This limited biota indicates somewhat oxygen-depleted bottom conditions, and that the vertebrates must have occupied a midwater zone.

In the past most specimens collected in the Kimmeridge area were ascribed to Kimmeridge Bay, although many are thought to have come from the cliffs further to the east, in an area known as the 'Kimmeridge Ledges', at Encombe Bay ([SY 927 776]–[SY 955 771]). Throughout the sequence scattered fish remains are common, and complete specimens are also found in the organic rich shales and coccolith limestone bands in the Bay. Fish material has been collected recently from the *hudlestoni* and *pectinatus* Zones at Rope Lake Head [SY 927 776] and to the east at Freshwater Point [SY 943 773]. The remains mostly occur as incomplete specimens, detached jaws, partial skulls, caudal fins and isolated teeth, but whole articulated fish are also fairly common throughout the sequence. Some fossils show soft tissue preservation.

Fauna

The fish fauna listed below is in the collection of Mr Steven Etches of Kimmeridge, Dorset.

Chondrichthyes: Elasmobranchii: Euselachii: Hybodontoidea

Asteracanthus spp.

Hybodus spp.

Chondrichthyes: Elasmobranchii: Neoselachii: Batomorphii

Asterodermus sp.

Chondrichthyes: Elasmobranchii: Chimaeriformes

Iscbyodus sp.

Brachymylus sp.

Osteichthyes: Actinopterygii: Neopterygii: Halecostomi

Gyrodus spp.

Lepidotes sp.

Osteichthyes: Actinopterygii: Neopterygii: Halecomorphi

Caturus spp.

Osteorachis sp.

Pachycormus sp.

Osteichthyes: Actinopterygii: Neopterygii: Teleostei

Aspidorhynchus sp.

Hypsocormus sp.

Allothrissops sp.

Eurycormus sp.

Leptolepis spp.

Pachythrissops sp.

Pholidophorus spp.

Thrissops sp.

Interpretation

The Kimmeridge Clay marks a period of widespread argillaceous sedimentation in north-west Europe in environments that were fully marine. The resulting thick series of clays and bituminous shales are considered to have been deposited in calm bottom waters, and anaerobic conditions may have prevailed in a stratified water column (Aigner, 1980), an environment similar to the present-day Black Sea. The sediments are essentially terrigenous in origin, indicating considerable erosion from a nearby landmass (? the London–Ardennes island and Cornubia), although there are no obvious plant macrofossils.

The shark fauna of the Kimmeridge Clay is similar to other Jurassic selachian assemblages in being composed largely of specifically indeterminate isolated material of the hybodonts *Asteracanthus* and *Hybodus.* Neoselachians are represented by a batoid genus '*Asterodermus*' sp. otherwise only known from the type and one other specimen from the Lower Tithonian lithographic limestones of Solnhöfen, Germany (Agassiz, 1833–45; Meyer, 1859). This primitive rhinobatid ray is represented by partial skeletons, which lack the head region, therefore the teeth of this genus are not known (Cappetta, 1987). The body is almost entirely covered by scales with star-shaped bases, and it is these which have been recovered from the Kimmeridge section (S. Etches, pers. comm., 1995). Chimaeroids are represented in the assemblage by the ubiquitous Jurassic genus *Ischyodus* and mandibular plates of *Brachymylus,* a form otherwise known from the Lower Oxford Clay of the English Midlands (Martill and Hudson, 1991).

The bony fish fauna comprises an assemblage similar to those of Mid Jurassic sections and the later Purbeck Limestone Formation. Halecostomids are represented by the cosmopolitan Jurassic genera *Lepidotes* and *Gyrodus,* and the halecomorphs *Aspidorhynchus* and *Caturus* are found in the Bathonian 'Stonesfield Slates' of Stonesfield (q.v.) and the Purbeck fish faunas of Durlston Bay (q.v.). Recently discovered is a *Caturus* sp. specimen with a coleoid lodged in the gullet, strongly suggesting that the fish could feed on relatively large prey (Etches and Clarke, 1993). A further caturid, *Osteorachis,* is also recorded from the Kimmeridge Clay succession. This fairly large caturid is also known from the Lias of southern Britain, and the Oxford Clay (Callovian–Oxfordian) of the English Midlands (Martin and Hudson, 1991). The stout-bodied pachycormids are well represented in the Kimmeridgian of Kimmeridge Bay, including two genera,

Pachycormus and *Hypsocormus,* which are long-ranging forms found in rocks of Early through to Late Jurassic age (Figure 12.23).

The Kimmeridge teleost assemblage contains species of the cosmopolitan Jurassic genera *Leptolepis* and *Pholidophorus,* and although the material is in excellent state of preservation (S. Etches, pers. comm., 1995), no specific determination has been made. However, it is fairly certain that the fauna will include the typical Upper Jurassic species diagnosed from the Purbeck Limestone Formation of Durlston Bay (q.v.). Pholidophorids are also represented in the fauna by *Eurycormus,* a stout-bodied form otherwise known from the Tithonian of Bavaria (Wagner, 1859b).

There are also two ichthyodectid genera in the fauna (Figure 12.23), *Pachythrissops* and *Thrissops,* which are similar to specimens recovered from the Late Jurassic succession at Durlston Bay (q.v.) and *Allothrissops,* an ichthy-odectid from the Tithonian of Bavaria (Nybelin, 1974a; Patterson and Rosen, 1977).

The preserved fauna from Kimmeridge Bay consists mainly of marine fish and medium- to large-sized marine reptiles (see Benton and Spencer, 1995). All of these were probably fish eaters, although they may also have fed on the abundant cephalopods.

Comparison with other localities

Kimmeridge Clay fish sites comparable to Kimmeridge Bay include the Lower Kimmeridge Clay outcrop (*baylei–mutabilis* Zones) in the area around Portland Harbour and Smallmouth Sands, Weymouth ([SY 669 764]–[SY 672 771]; Woodward, 1901; Arkell, 1933; Cox and Gallois, 1981). Little in the way of large specimens has been collected recently from this locality, because the enclosure of Portland Harbour has reduced erosion. However, the relevant beds (*cymodoce* Zone) have been re-excavated and finds, including teeth, jaws, vertebrae and fin spines, continue to be made by bulk sampling the oyster-rich clay beds, which are exposed behind the rapidly eroding sea defences (A. Brokenshire, pers. comm., 1995; S. Etches, pers. comm., 1995). The faunal list given by A. Brokenshire (pers. comm., 1995) for this site includes hybodont sharks (*Hybodus, Sphenodus,* and *Asteracanthus*), neoselachians (*Synechodus,* squatinomorphs, squalomorphs, galeomorphs and batomorphs), chimaeroids (*Bractymylus, Ischyodus* and *?Elasmodectes*), halecostomes (*Lepidotes, Macromesodon* and *Gyrodus*), halecomorphs (*Belonostomus, Hypsocormus, Aspidorhynchus* and *Caturus*)and teleosts (pholidophorid material, *Sphaeronthus* otoliths and *Eurycormus*). In addition, specimens are occasionally found offshore from this site, and in the degraded Kimmeridge Clay beds west of the classic site. C. Underwood (pers. comm., 1997) has recently found a diverse microshark fauna, including *Hybodus, Synechodus, Protospinax,* '*Squatina*'and possibly *Oroctoloboides,* within the basal Kimmeridge Clay (*baylei* Zone). He also noted a similar assemblage, with the addition of *Parasymbolus, Spathobatis* and *Heterodontus,* in the underlying Sandsfoot Formation of the Upper Oxfordian.

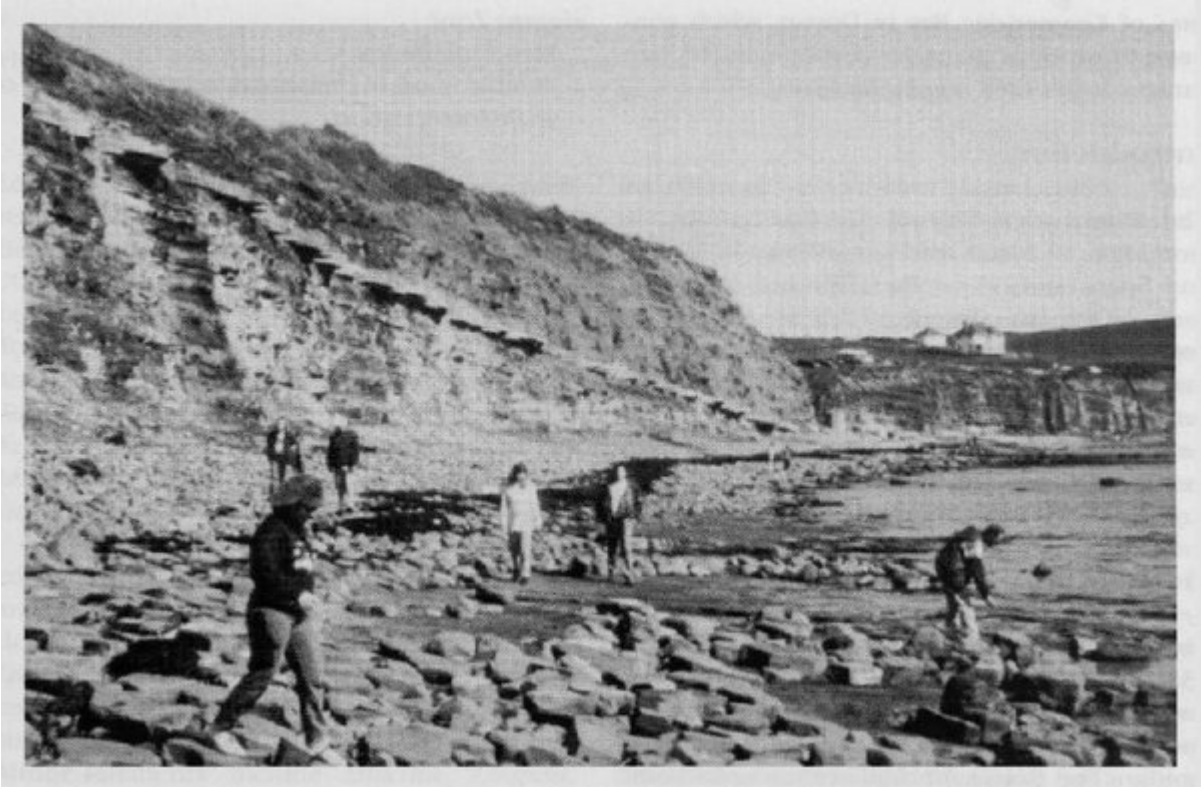
Sites comparable to the Kimmeridge section, include Swindon Brick and Tile Works (Lower Kimmeridge Clay), Wiltshire [SU 142 838]; Chawley Brick Pit, Cumnor Hurst, near Oxford, Oxfordshire [SP 475 043]; Oday Hill landfill site, Oxfordshire [SP 492 948]; Ely, Cambridgeshire (probably one of several pits at [TL 55508]); Wootton Bassett, Wiltshire ([SU 06 38]), and Gillingham, Dorset [ST 809 258].

Foreign occurrences of Kimmeridge-age marine fossil fish faunas are from the Late Jurassic of Switzerland, southern Germany, and Normandy, France, including the famous Lithographic Limestone (Tithonian) assemblage of Bavaria, as well as the Late Jurassic of Portugal and the Portlandian of Switzerland and Austria. There are also numerous fossil fish-bearing Mid–Late Jurassic deposits in Wyoming, South Dakota, Colorado, New Mexico, northern Chile and western Cuba (Schaeffer and Patterson, 1984).

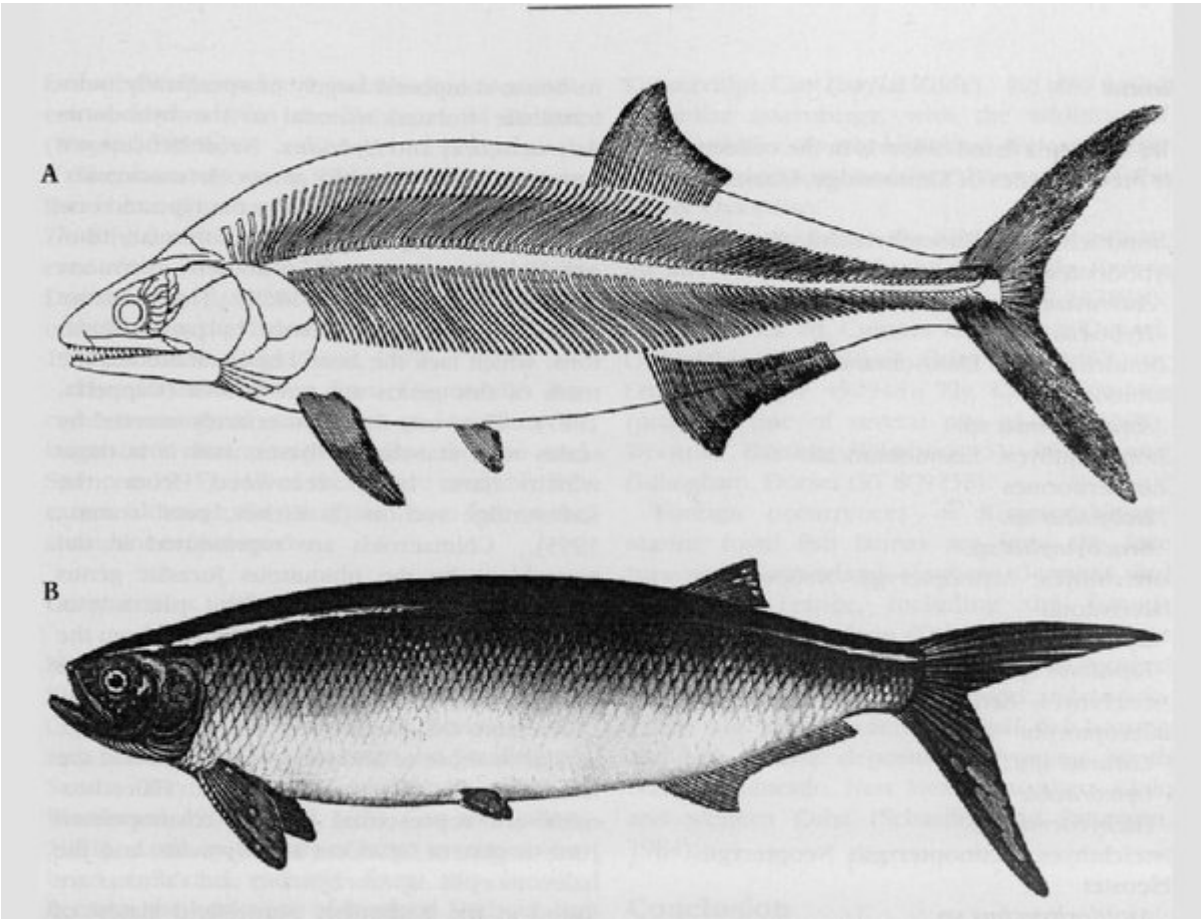
Conclusion

The cliffs and foreshore exposures of the Kimmeridge Clay at Kimmeridge Bay yield a Late Jurassic fauna of exceptionally preserved fossil fish which rival the famous Tithonian age assemblages of southern Germany and give the site its conservation value. The cliffs are subject to continuing erosion, and fresh finds continue to be made every year.

References



(Figure 12.22) The shales and cementstones of the Kimmeridgian at Kimmeridge Bay, facing south (photo: M.J. Benton).



(Figure 12.23) Fish from the Kimmeridgian: (A) Hypsocormus, sp. x 0.25 restoration by Woodward (1891, © The Natural History Museum, London); (B) Thrissops sp. x 0.5 restoration after Cox et al., 1988.