Totternhoe (Chalk Quarry)

[SP 982 222]

Highlights

The Totternhoe Stone is an important phosphatic and fish-bearing horizon that can be traced across much of the Lower Chalk outcrop in southern England. At Totternhoe Chalk Quarry in Bedfordshire, the unit has yielded an abundant, but fragmentary fish fauna consisting largely of teeth, concentrated within the winnowed basal limestone.

Introduction

The Chalk Quarry at Totternhoe is the only locality where the famous Totternhoe Stone is well exposed. The Totternhoe Stone (Lower Chalk: Cenomanian) is a massive gritty limestone, with a basal concentration of phosphatized nodules, which forms a well-known and distinct litholog-ical marker band in the Lower Chalk across much of the central English Chalk outcrop. It has traditionally been used as a boundary for the base of the Middle Cenomanian (A. *rhotomagenese* Zone) Grey Chalk succession (Figure 13.14).

It is best developed in parts of Bedfordshire, Hertfordshire and Cambridgeshire, where it attains thicknesses of up to 6 m and was formerly mined as an attractive and hard-wearing building stone (Jukes-Browne and Hill, 1903). At outcrop the hard Totternhoe Stone usually forms a slight rise above the low escarpment of the denuded Chalk Marl (Lower Cenomanian: *M. dixoni* and *M. mantelli* Zones).

At Totternhoe the Stone forms a spur of the Dunstable plateau. The large quarries in the northern part of the hill above Totternhoe are now disused and overgrown, but access to these sections can be gained through the working chalk quarry and cement works situated directly to the north of Lower End, Totternhoe. A small exploratory pit in the floor of the chalk quarry has been retained as an SSSI and is maintained as a source of Totternhoe Stone for architectural restoration projects (Page, 1993). The phosphate-rich basal lag accumulation is exposed in the excavation and it is this horizon that has yielded abundant fish remains. The fauna includes an important microshark component, some of which has yet to be formally described, and there is much potential for future finds to be made by bulk sampling.

The geology of the Totternhoe Stone has long been studied, with early descriptions including Jukes-Browne (1889), Jukes-Browne and Hill (1903), Jukes-Browne and White (1908) and Hopkinson (1889). More recent reports on the stratigraphy of the site include British Geological Survey technical reports by Aldiss (1992) and Wood (1992). The fishes are listed in Jukes-Browne and Hill (1903).

Description

The Totternhoe Stone is a massive gritty calcarenite, with a discontinuous lag of phosphatic nodules. Although the Totternhoe Chalk Quarry is regarded as the type section of the rock, its development there is not typical (Aldiss, 1992). The beds of Chalk Marl immediately below the Totternhoe Stone at Totternhoe are much older (*?M. mantelli* Zone) than elsewhere (Aldiss, 1992). Typically the Totternhoe Stone in central-eastern England is around 1–2 m in thickness, thinning to around 0.5 m at Hunstanton, in Norfolk (Chatwin, 1954). It attains its maximum thickness (5–6 m) in the type section (Aldiss, 1992). A section in the northern part of the Chalk quarries at Totternhoe was described by Jukes-Browne and Hill (1903) and is given here with few modifications from recent accounts by Aldiss (1992) and Page (1993):

	Thickness
Grey Chalk (top not seen: A. *rhotomagense* Zone)	
White chalk, with thin band of yellow nodules at base	20–25 ft [6–7.5 m]
Firm greyish-white chalk	35–40 ft [11–12 m]
Tough grey chalk, slightly gritty and shelly in places	5 [1.5 m]

Totternhoe Stone	
Firm, grey sandy stone in thick beds 9 ft	[2.7 m]
Hard, brownish stone in two massive beds	8 ft [2.4 m]
Hard, brownish stone in three beds, with many phosphatic clasts at the base	5 ft [1.5 m]
Chalk Marl (*?M. mantelli* Zone)	
Soft dark bluish grey marl	0.2 m to base of quarry

The gritty texture of the Totternhoe Stone is caused by a mixture of fine shell fragments, green glauconite grains and brown phosphatised pellets (about 1 mm in diameter) and nodules (up to 30 mm in diameter; Jukes-Browne and White, 1908). The calcarenite unit is overlain by laminated marly chalk, which is locally interlayered with Totternhoe Stone calcarenite facies (Aldiss, 1992). Shelly limestone beds are also found locally throughout 7 m of the overlying Lower Chalk sequence (Aldiss, 1992). Even around the type locality, the Totternhoe Stone is extremely variable laterally (Aldiss, 1992).

Macrofossils are rare in the Totternhoe Stone, but include rhynchonellid shell debris, bivalves, fish debris and occasional cephalopods (Aldiss, 1992). The bivalve *Pecten* (*Chamlys*) *fissicosta* is confined to the Totternhoe Stone (Chatwin, 1954). The trace fossil *Teichichnus* occurs above the phosphatic basal lag and an extensive system of *Thalassinoides* burrows, infilled with calcarenite, occurs below the deposit in the quarry (Aldiss, 1992). The phosphatic nodules concentrated in the lowest 0.5 m of the bed enclose phosphatized sponges, rolled selachian teeth and other vertebrate debris. Some of the nodules have been bored and encrusted with ser-pulids and oysters (Aldiss, 1992). The Totternhoe Stone becomes slightly more pyritous towards the uppermost 0.4 m of the unit (Aldiss, 1992).

The vertebrate fauna mainly comprises isolated teeth, bones and coprolites, although Jukes-Browne (1903) recorded partial specimens of the coelacanth *Macropoma.* Most of the larger vertebrate remains are concentrated in the basal lag and much of the fish material is abraded and encrusted. The Totternhoe Stone is clearly a reworked, winnowed deposit, developed during a hiatus in Chalk sedimentation above a burrowed and encrusted hardground surface formed within the underlying Chalk Marl.

Fauna

The list of fishes recovered from the base of the Totternhoe Stone at the Chalk Quarry is based on collections of larger material made in the 19th century, and recorded by Jukes-Browne and Hill (1903), and microvertebrate finds made from bulk sampling and acid preparation of the limestones by D. Ward (pers. comm., 1995). A proportion of this second component is housed in Bedford Museum (BMB) and has not yet been formally described.

Chondrichthyes: Elasmobranchii: Euselachii: Hybodontoidea

Ptychodus sp.

Chondrichthyes: Elasmobranchii: Neoselachii: Squalomorphii

Hexanchus (*Notidanus*) *microdon* (Agassiz, 1843)

Protosqualus sp.

Chondrichthyes: Elasmobranchii: Neoselachii: Squatinomorphii

Squatina sp.

Chondrichthyes: Elasmobranchii: Neoselachii: Galeomorphii

Cretolamna (*Lamna*) *appendiculata* (Agassiz, 1843)

Cretolamna sp.

Leptostyrax sp.

Paranomotodon (*Oxyrhina*)sp.

Paraorthacodus sp.

Scapanorhynchus subulatus (Agassiz, 1843)

Scyliorhinus sp.

Squalicorax (*Corax*) *falcatus* (Agassiz, 1843)

Synechodus sp.

Synodontaspis (*Carcharias*) *striatula* (Dalinkevicius, 1935)

Chondrichthyes: Elasmobranchii: Neoselachii: Batomorphii

Squatirhina sp.

Turonibatis cappettai Landemaine, 1991

Osteichthyes: Actinopterygii: Neopterygii: Euteleostei

Cimolichthys striatus

Osteichthyes: Sarcopterygii: Actinistia

Macropoma sp.

Fish remains have also been recovered from the Lower Chalk succession above the Totternhoe Stone at Totternhoe Stone Quarry and these were listed by Jukes-Browne and Hill (1903): Chondrichthyes: Elasmobranchii: Euselachii: Hybodontoidea

Ptychodus decurrens Agassiz, 1835–1839

Chondrichthyes: Elasmobranchii: Neoselachii: Squalomorphii

Hexanchus (*Notidanus*) *microdon* (Agassiz, 1843)

Chondrichthyes: Elasmobranchii: Neoselachii: Galeomorphii

Cretolamna (*Lamna*) *appendiculata* (Agassiz, 1843)

Paranomotodon (*Oxyrhirza*) sp.

Scapanorhynchus subulatus (Agassiz, 1843)

Interpretation

The Totternhoe Stone represents a lag deposit formed during a break in sedimentation in the Lower Chalk succession. Clearly, any fish remains found within this horizon have been concentrated by this hiatus and may have been reworked from older deposits. Aldiss (1992) suggested that the hardground developed at Totternhoe may have persisted through much of the Lower and Middle Cenomanian and hence represents a significant time of non-deposition and reworking. However, the Totternhoe Stone is an important source of Lower Chalk fishes and their ages are roughly constrained to the *M. dixoni* and basal A. *rhotomagetzse* Zones. The overlying Lower Chalk at Totternhoe has also yielded fossil fish remains, but is not nearly as productive as the Totternhoe Stone.

The Totternhoe Stone contains an abundance of small shark teeth (Figure 13.15), as well as the usual ptychodont component, including representatives of the squalomorph, squatinomorph, galeomorph and batomorph neoselachians. The squalomorphs are represented by two small species (Figure 13.15), *Hexanchus microdon* (Agassiz) and *Protosqualus* sp. (Figure 13.15). The comb-like teeth of *H. microdon* have been recovered from other Chalk localities, such as Blue Bell Hill (q.v.), but is a fairly rare Chalk fossil (Longbottom and Patterson, 1987). The teeth of *Protosqualus* are extremely tiny (less than 3 mm in width) and are usually found in rocks of a Lower Cretaceous age (Cappetta, 1987), although possible *Protosqualus* teeth have been described from the Upper Cretaceous of Lithuania (Dalinkevicius, 1935). They typically possess a short cusp that leans towards the rear of the tooth and a smooth cutting edge, and a wide basal apron, which slightly protrudes over the root (Cappetta, 1987).

The superorder Squatinomorphii contains only one extant genus, the living monk-fish or angel shark, *Squatina* (Cappetta, 1987). *Squatina* has adapted to a benthic way of life by developing a flattened body and enlarged pectoral fins, like the rays and skates (Superorder Batomorphii). *Squatina* is known from complete specimens from the Upper Jurassic of Germany (Thies, 1983) and fragmentary remains from most Mesozoic and Cenozoic series (Cappetta, 1987). Its dentition remained fairly conservative over this time, and this has made separation of species based on isolated teeth extremely difficult (Cappetta, 1987). Woodward (1902–1912) described teeth of *Squatina* from the Cenomanian of Clayton, Brighton and Lewes in Sussex and from the Campanian of Norwich. The living genus is found in all tropical and temperate seas.

As well as the usual complement of large lam-niform piercing teeth, such as the cretoxyrhinid *Cretolamna appendiculata* (Agassiz), the alopiid *Paranomotodon* sp., the mitsukurhinid *Scapanorhynchus subulatus* (Agassiz) and the anacoracid *Squalicorax falcatus* (Agassiz) found in the Lower Chalk of Totternhoe and other localities (Longbottom and Patterson, 1987, and see Blue Bell Hill report), the acid residues have produced a more complete galeomorph assemblage (Ward, pers. comm., 1995).

Leptostyrax ((Figure 13.15)B) was a small cretoxyrhinid lamniform, known previously from the Albian and Coniacian of North America and parts of western Europe (Herman, 1977; Cappetta, 1987). The teeth are characterized by a large central cusp, with prominent cutting edge flanked by two or four smaller cusps (Cappetta, 1987; (Figure 13.15)B). *Synodontaspis striatula* (Dalinkevicius) is a odontaspid lamniform shark with large tearing-type teeth (up to 40 mm in height; Gluckman, 1964a; (Figure 13.15)C), indicating a fish perhaps 4 m long. *Synodontaspis,* or *Carcharias* as it is also known, is an extant genus, which is widespread in the warm temperate and tropical waters of the Mediterranean, Atlantic, Indian and western Pacific oceans (Cappetta, 1987).

The galeomorph assemblage also includes a representative of the Carcharhiniformes, the extant scyliorhinid or dogfish, *Scyliorhinus,* whose tiny teeth (less than 8 mm in height) are common from the Middle Jurassic upwards (S. Metcalf and C. Underwood, pers.comm.). Woodward (1899b, 1902–1911) described two scyliorhinids, *S. dubius,* from the Lower Chalk of Dover, Kent, and *S. antiquus* (Agassiz) from the Turonian Chalk of Blue Bell Hill (q.v.).

Teeth of the small enigmatic palaeospinacid sharks, *Synechodus* and *Paraorthacodus,* have also been recovered from acid digestion of the Totternhoe Stone (Figure 13.15)D,E. *Synechodus* is a fairly common component of the Lower Chalk fauna, and is known from fragmentary skeletal remains of two species, *S. dubrisensis* (Mackie) of Dover and *S. nitidus* Woodward from Snodland and Wouldham, Kent, as well as isolated teeth recovered from acid residues at many localities (Woodward, 1902–1912). *Paraorthacodus* has similar, but typically larger, teeth (up to 20 mm in height), these can usually be distinguished by details in dental morphology (Cappetta, 1987).

Completing the elasmobranch fauna at Totternhoe are the two batoids *Squatirhina* sp. and *Turonibatis cappettai* Landemaine (Ward, pers. comm., 1995). *Squatirhina* is a Cretaceous ray of uncertain taxonomic position (Cappetta, 1987), which possessed small mesiodistally compressed teeth, up to 5 mm in height (Figure 13.15)F. Previous authors have assigned the genus to an intermediate position between the squatinids and orectolobids or scyliorhinds and rhinobatids (Casier, 1947), or within the orectolobids (Estes, 1964; Herman, 1977). However, Cappetta (1987) states that the genus is almost certainly an enigmatic rhinobatoid.

The Totternhoe Stone assemblage is completed by the barbed teeth of the 'enchodont' euteleost *Cinzolichthes,* and coprolites dubiously assigned to the coelacanth *Macropoma* (Jukes-Browne and Hill, 1903).

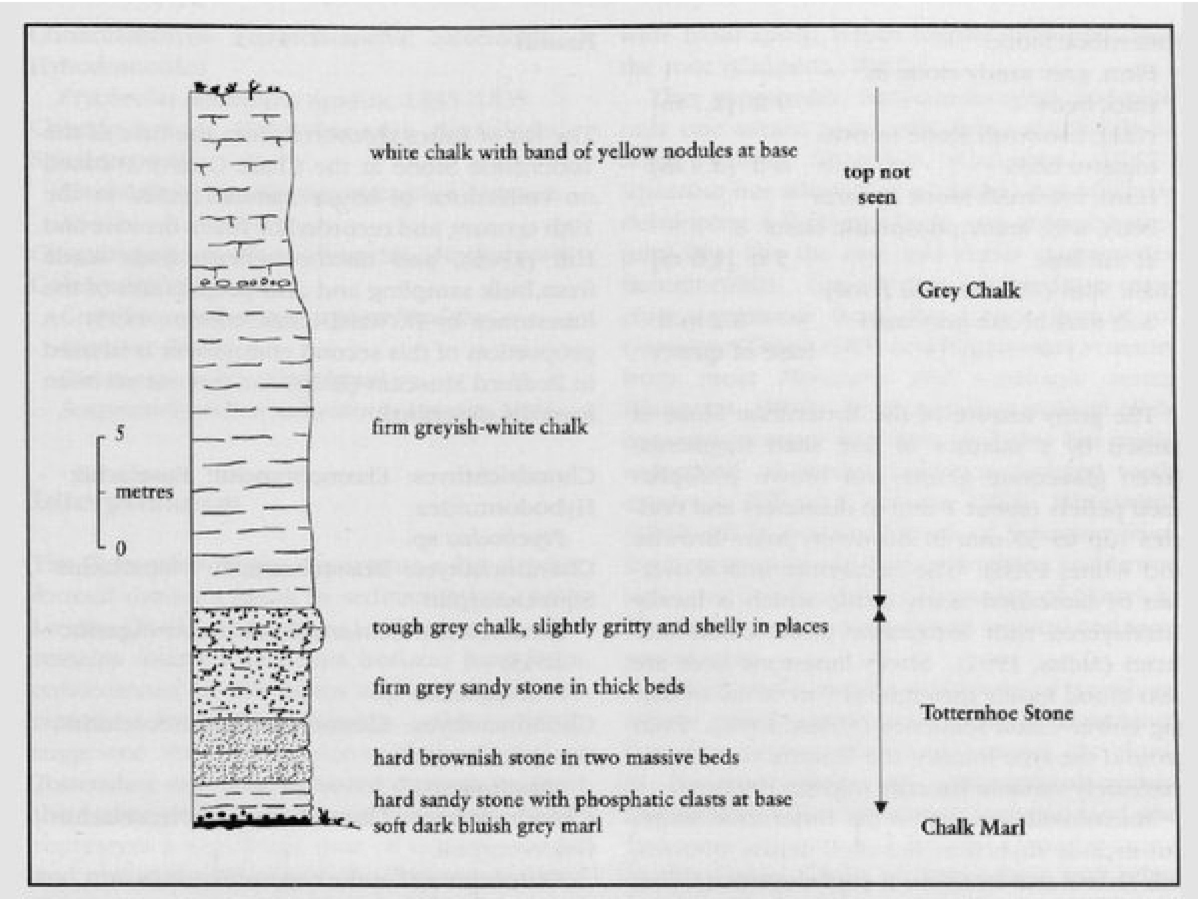
Comparison with other localities

The Totternhoe Stone of neighbouring counties has also yielded an extensive vertebrate assemblage. The Arlesey Quarries, Hitchin ([TL 19 36]), yielded whole specimens of the cutcicosts *Ctenothrissa* and *Dercetis elongatus,* as well as isolated selachian teeth and bones of the coelacanth *Macropoma* (Jukes-Browne and Hill, 1903), fish remains were also recovered in the nearby Hitchin Station Quarry ([TL 19 29]; Jukes-Browne and Hill, 1903). The Totternhoe Stone at Cherry Hinton, Cambridge ([TL 483 557], [TL 485 558]), was also extremely fossiliferous with eight species of fish recorded by Jukes-Browne and Hill (1903). A similar fauna was recovered from the same horizon at Hunstanton cliffs in Norfolk. However, apart from the coastal section, all the other exposures no longer exist.

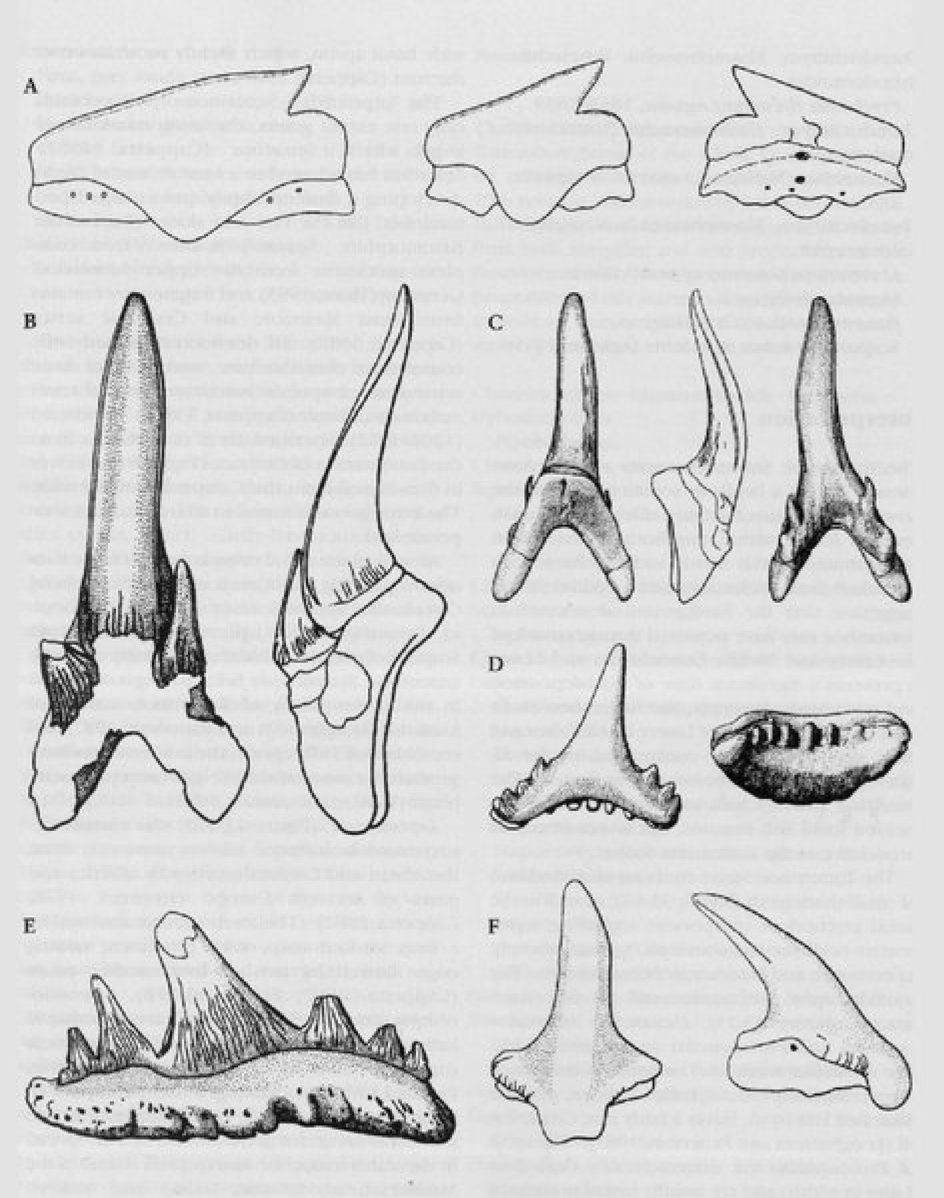
Conclusion

The conservation value of the site is derived from the phosphatic pebble bed exposed at the base of the Totternhoe Stone, which is one of the richest sources of Upper Cretaceous microshark remains, some of which have yet to be formally described. The site has great potential for new finds.

References



(Figure 13.14) Totternhoe Chalk stratigraphical log (after P.J. Smart).



(Figure 13.15) Fossil chondrichthyan teeth genera from the Chalk at Totternhoe (after Cappetta, 1987). (A) Protosqualus sp., x 24; (B) Leptostyrax sp., x 1.25 in distal view; (C) Synodontaspis (Carcharias) striatula, x 2 in distal view; (D) Synechodus sp. x 5; (E) Paraorthacodus sp., x 4; (F) Squatirhina sp., x 10, in labial and distal views.