

Mesozoic Res.	2(4)	153-161	2 Plates, 4 Text-figs, 1 Table	Leiden 1990
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The first record of a bitten ammonite from the Middle Oxford Clay (Callovian, Middle Jurassic) of Bletchley, Buckinghamshire

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Abstract: An uncrushed specimen of *Kosmoceras* (*Gulielmiceras*) *gulielmi* (J. Sowerby) possessing a number of circular and elliptical punctures and indentations is described. The damage is interpreted as being the result of a fatal encounter with an unknown marine reptile.

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Accepted: 20 November 1989

INTRODUCTION

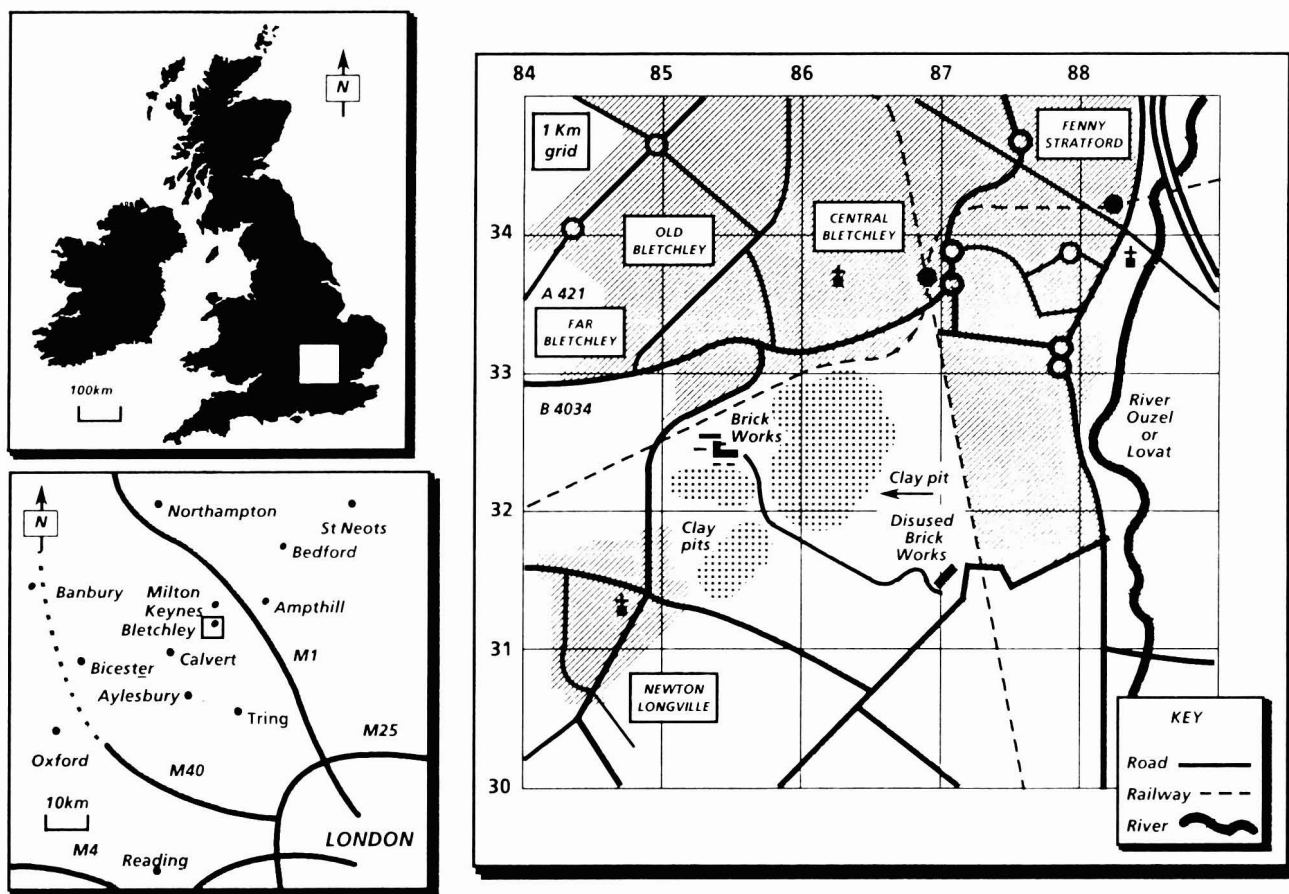
Natural inland exposures of the Middle Oxford Clay are rare and almost entirely confined to outcrops found in pits of the London Brick Company near Bedford, Bletchley and Calvert in central southern England (Fig. 1). All of the pits exploit the shales of the Lower Oxford Clay for the production of Fletton bricks and the overlying Middle Oxford Clay which is unsuitable for brick production, due to its low organic content, is removed and used for landfill purposes.

During the month of June 1988 an extensive tract of Middle Oxford Clay overburden, locally referred to as "Callow", was removed from the eastern flank of the L.B.C. brickworks at Newton Longville, Bletchley (Grid reference SP 866323) in preparation for the extension of the main working face. The heavy rainfall of June and early July revealed large numbers of uncrushed pyritised ammonites from a horizon approximately 8 metres above the base of the Middle Oxford Clay (Text-figs 2, 3). One of the specimens, after preparation revealed a series of perforations and depressions which are interpreted as evidence of predation. It is housed in the collections of the Department of Palaeontology, British Museum (Natural History) registration number; C. 933414.

Despite the fact that ammonites must have been an important link in the marine food chain, documented cases of predation are extremely rare. Wetzel (1960) described (? regurgitated) pellets derived from plesiosaurs in which he found ammonite larvae and shells of adult *Baculites*. The most celebrated occurrence was described by Kauffman & Kesling (1960) who describe mosasaur-bitten specimens of the Late Cretaceous ammonite *Placentiaceras*. Lehmann (1961) cites several cases of damage to Early Jurassic ammonite shells which he attributes to fish and, in one case (ibid. p.194), crabs. The only Palaeozoic case of cephalopod predation is in an unnamed nautiloid that Mapes & Hanson (1984) concluded was attacked by a cladodont shark.

DESCRIPTION OF BITTEN SPECIMEN

The ammonite is a large, virtually uncrushed, specimen of *Kosmoceras* (*Gulielmiceras*) *gulielmi* (J. Sowerby) lacking part of the body chamber. The shell and its inner lining has been replaced with pyrite. The inside of the body chamber was filled with calcite indurated mudstone. This was also present in the umbilical region and as cemented overgrowths, overlying some of the bites. This was in turn overlain by late diagenetic pyrite. It was only when the mudstone was removed by immersion in dilute formic acid that locally crushed or pierced areas of shell were visible. These compare well with those figured by both Mapes & Hanson (1984) and Kauffman & Kesling (1960) and are concluded to represent bite marks made by a vertebrate predator. The possibility of other causes (see Mapes & Hanson 1984:117) were considered but rejected for reasons discussed below.



Text-fig. 1. Location of Bletchley Brickpit.

Twenty possible bite marks have been identified, three on one face and sixteen on the other. They are indicated and numbered on Plates 1 and Text-fig. 4. With two exceptions, numbers 17 and 20, they are confined to the rear portion of the shell; that is opposite to the soft parts. The majority are indentations rather than punctures that penetrate the shell. Some are double strikes, in two or more bites are superimposed, modifying the shape of the indentation. The nature of the individual bites is given in Table 1.

The indentations are generally circular or ovoid, between four and six millimetres in diameter and less than two millimetres deep. Within the area of the indentation, the shell is broken into a series of abutting polygonal plaques. Where the bite punctured the body chamber (bite 1) the hole is surrounded by an inwardly inclined ring of fractured shell. A similar effect is seen where a tooth has glanced obliquely against the shell (bites 12 and 16). There is no sign of healing suggesting that the damage was fatal to the ammonite.

The side of the shell with only three recognised bite marks has been crushed inwards along cracks (Plate 1a, a-d). Within the body chamber are a series of intersecting pyritised tubes presumed to be worm burrows.

TAPHONOMY

The attack

A large measure of speculation begins at this point; the scenario presented is probably an oversimplification of the actual event. The presence of bite marks concentrated on one half of the shell indicates the direction of the attack, in this case from above and behind. Several lines of bites are apparent (Text-fig. 4b) suggesting that the shell was grasped, released and rotated several times. The final bite will have separated the ammonite's soft parts and part of the body chamber from the rest of the shell, which then sank to the sea bed. This is a similar fate as that suggested for the ammonite *Placentiaceras* by Kauffman & Kesling (1960:234). With the large

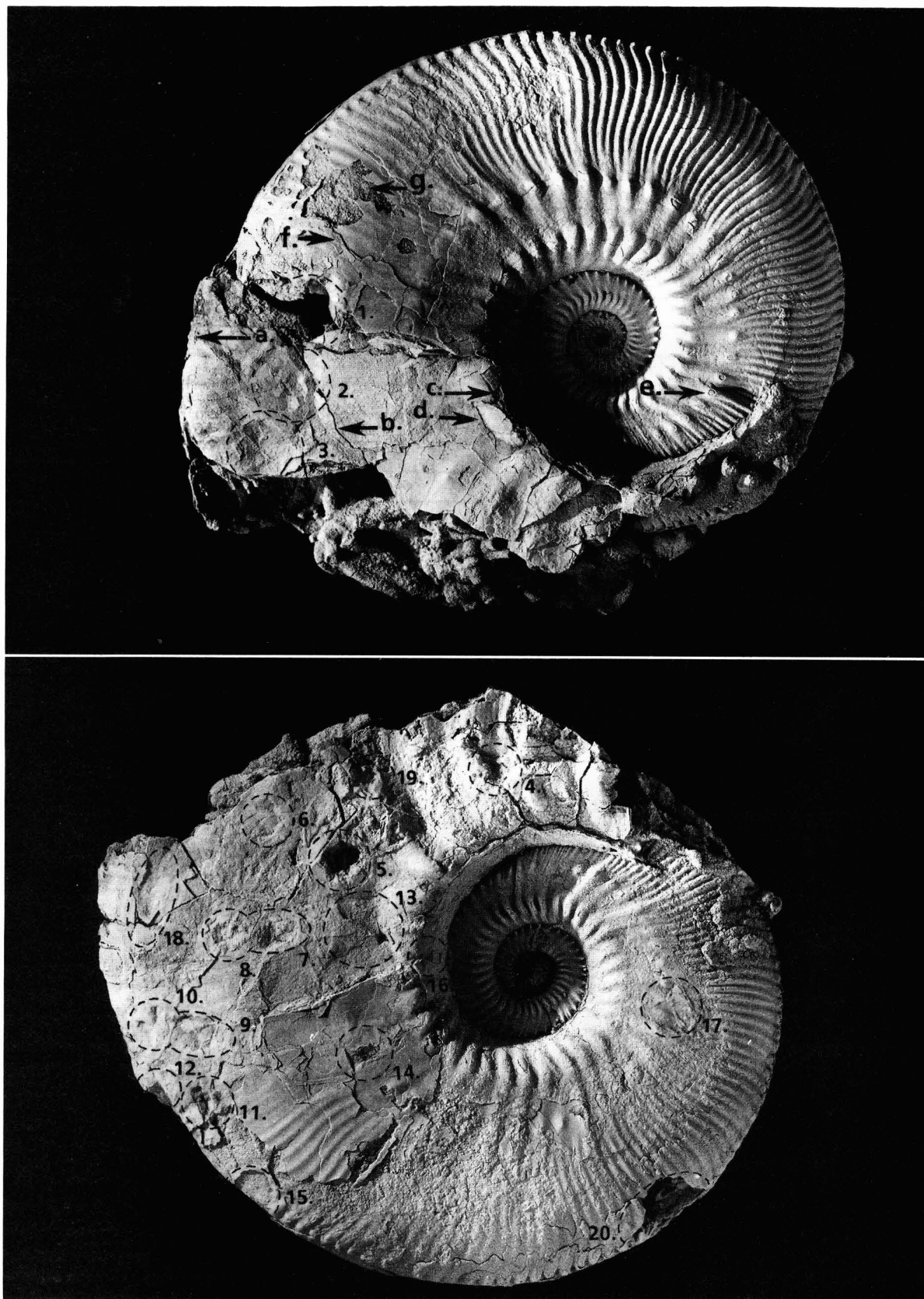


Plate 1. *Kosmoceras (Guliemiceras) gulielmi* (J. Sowerby), BM(NH) C. 933414, Middle Oxford Clay (Middle Jurassic, Callovian), Newton Longville, Bletchley SP 866323, both faces $\times 1.5$.

Bite No.	Max diameter (mm)	Min. diameter (mm)	Type of bite		Comments
			Puncture or dent	Single or multiple strike	
1	5.7	?	puncture	? multiple	Hole modified by the cracked body chamber.
2	3.7	4.2	dent	single	
3	5.5	4.6	dent	? multiple	
4	7.5	5.5	dent	multiple	
5	4.4	3.2	puncture	single	
6	4.6	3.7	dent	multiple	
7	5.2	3.4	dent	multiple	
8	4.3	3.2	dent	single	
9	5.8	3.2	dent	multiple	
10	4.8	4.0	dent	single	
11	7.2	4.8	dent	multiple	
12	-	-	puncture	multiple	A glancing bite on the outer rim.
13	9.2	7.9	puncture	multiple	
14	-	-	artifact	-	Probably not a bite, rather an abraded tubercle
15	5.2	-	? artifact	single	Appears to be dent but shell is missing so doubtful.
16	-	-	dent	single	A glancing bite on the inner (umbilical) rim.
17	8.1	4.0	dent	single	
18	11.5	5.3	dent	multiple	
19	3.6	3.0	dent	single	
20	-	6.0	puncture	single	The bite punctured the floatation chamber.

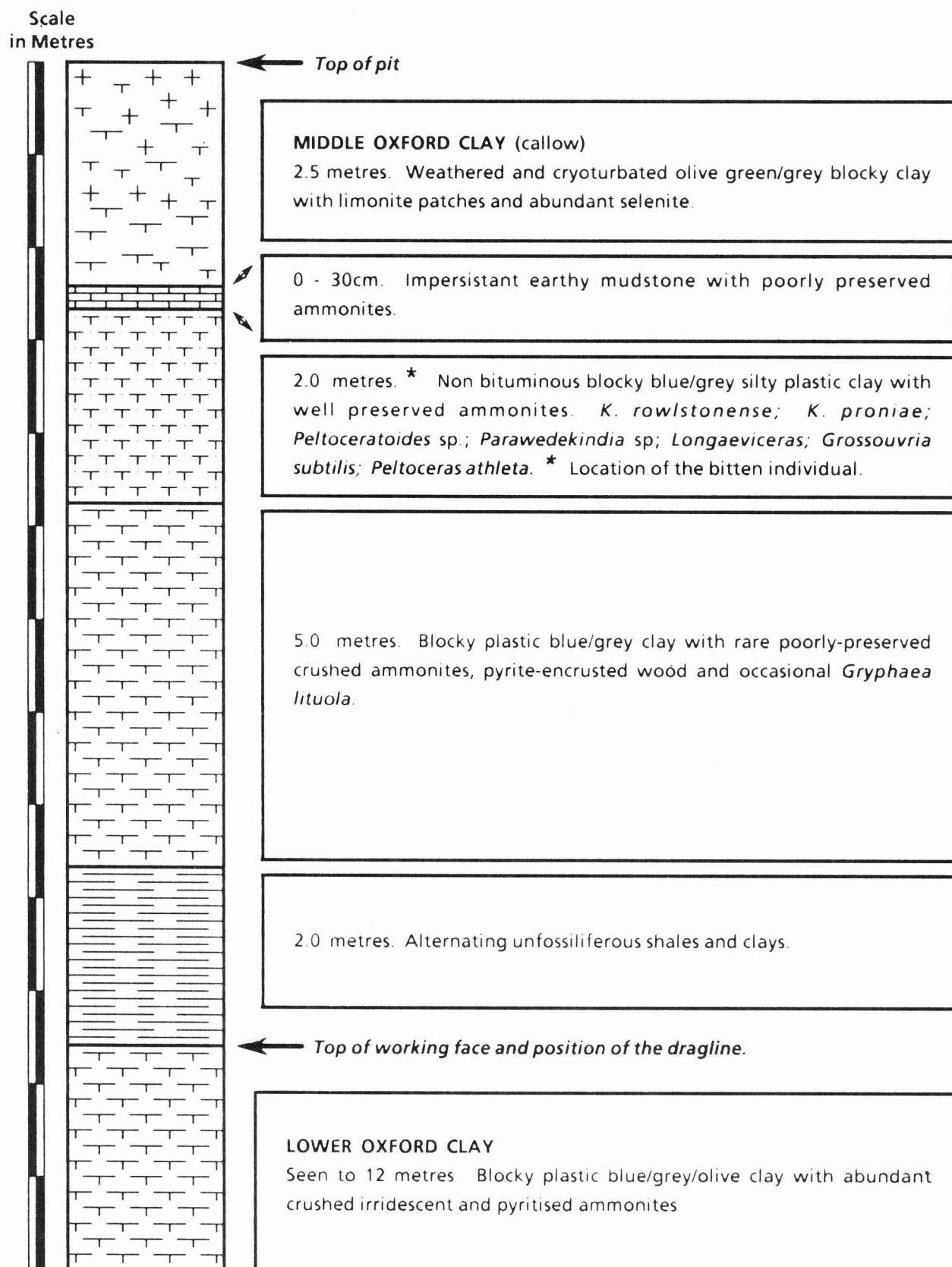
Table 1. Dimensions of the presumed punctures and identations.

number of bites present it is tempting to try to group them into lines representing the prints of successive teeth on a jaw ramus. There are however, many different lines of three or more bites. Those suggested in Text-fig. 4b were chosen because they appear to stand out in the specimen, being similar in depth and separation. Other interpretations are possible but do not alter the point being made.

One must assume that an ammonite would possess a wide field of vision, and so sneaking up upon one would be a difficult task. At first glance one would expect that the visual lure of the victim's soft parts would initiate an attack from the front. This however would give the ammonite a chance to escape using a rapidly expelled jet of water; in the manner of the living *Nautilus*. An attack from behind thus reduces the victim's chance of escape. An attack from above could also puncture and flood one or more of the floatation chambers. This would result in a loss of buoyancy and render the ammonite virtually helpless. A predator could then separate the soft parts from the shell at its leisure. It is quite likely that this hunting strategy was independently developed by a number of predators, as being the most successful way to attack an ammonite.

Burial diagenesis

Lying on the sea bed, separated from the soft parts, the crushed shell underwent rapid pyritisation. The presence of undistorted worm casts in the crushed remains of the body chamber suggest that (1) conditions were not wholly anoxic and (2) that initial pyritisation predated sediment compaction and that the body chamber was crushed prior to pyritisation. The fact that the crushed areas of shell remained together rather than being scattered suggests the presence of an inner lining membrane, or an outer periostracal film. A similar result can be seen if a hen's egg is lightly crushed. The membranous lining would decompose rapidly and probably acted as a focus for the onset of pyritisation. Pyritisation of the ammonite was completed prior to sediment compaction, producing an uncrushed external cast. The blebs of indurated mudstone over some of the bites also suggest a late phase of calcification of the sediment during burial diagenesis. A second phase of pyrite diagenesis is indicated as secondary overgrowths over indurated mudstone in the umbilical region of the ammonite.



Text-fig. 2. Faunal Zones and Subzones of the Middle and Lower Oxford Clay. Modified from Cope *et al.* 1980.

ZONES		SUBZONES	LITHOSTRAT.
C A L L O V I A N	<i>Peltoceras athleta</i>	<i>Kosmoceras spinosom</i>	MIDDLE OXFORD CLAY
		<i>Kosmoceras proniae</i>	
		<i>Kosmoceras phaeinum</i>	LOWER OXFORD CLAY
	<i>Erymnoceras coronatum</i>	<i>Kosmoceras grossouvrei</i>	
		<i>Kosmoceras obductum</i>	
	<i>Kosmoceras jason</i>	<i>Kosmoceras jason</i>	
		<i>Kosmoceras medea</i>	

Text-fig. 3. Simplified lithological profile of the Middle and Upper Oxford Clay exposed in Bletchley Brickpit.

WHAT WAS THE PREDATOR?

Mapes & Hanson (1984) suggest three criteria for recognising shark/nautiloid predation that modified, can apply to any large vertebrate predator. These are:

- 1) Comparatively large circular to oval holes or indentations.
- 2) A non-random patterns of punctures.
- 3) An inwardly crushed shell around the perimeters of the punctures.

The specimen described above, satisfies criteria 1) and 3). We feel that the localised distribution of the indentations including the high frequency of multiple bites is certainly "non-random" and thus satisfies criteria 2).

In order to find the identity of the predator, we must consider the large canivores known to exist in the Middle Oxford Clay times.

These are:

Pterosaurs: *Rhamphorhynchus*.

Ichthyosaurs: *Ophthalmosaurus*.

Pliosaurus: *Liopleurodon*, *Peloneustes*, *Pliosaurus*, *Simolestes*.

Plesiosaurs: *Muraenosaurus*, *Tricleidus*, *Cryptoclidus*.

Crocodyles: *Metriorhynchus*, *Steneosaurus*.

Sharks: *Hybodus*, *Notidanoides*.

Bony fish: *Hypsocormus*. (fish with unsuitable (crushing grinding and rasping) dentitions have been omitted)

The vision of a pterosaur swooping down and grabbing an ammonite is as attractive as it is unlikely. Unfortunately, known specimens of *Rhamphorhynchus* are too small for the task and possessed flattened pointed teeth (Wellhofer 1975).

Although Mapes & Hanson (1984) concluded that their nautiloid was attacked by a cladodont shark, the teeth of the sharks *Hybodus* and *Notidanoides* are labio-lingually flattened and are unlikely to be able to cause the indentations seen. The large carnivorous bony fish *Hypsocormus* has stout conical teeth but whose pointed tips would be more likely to pierce the shell rather than dent it (see Woodward 1895, pl. 11).

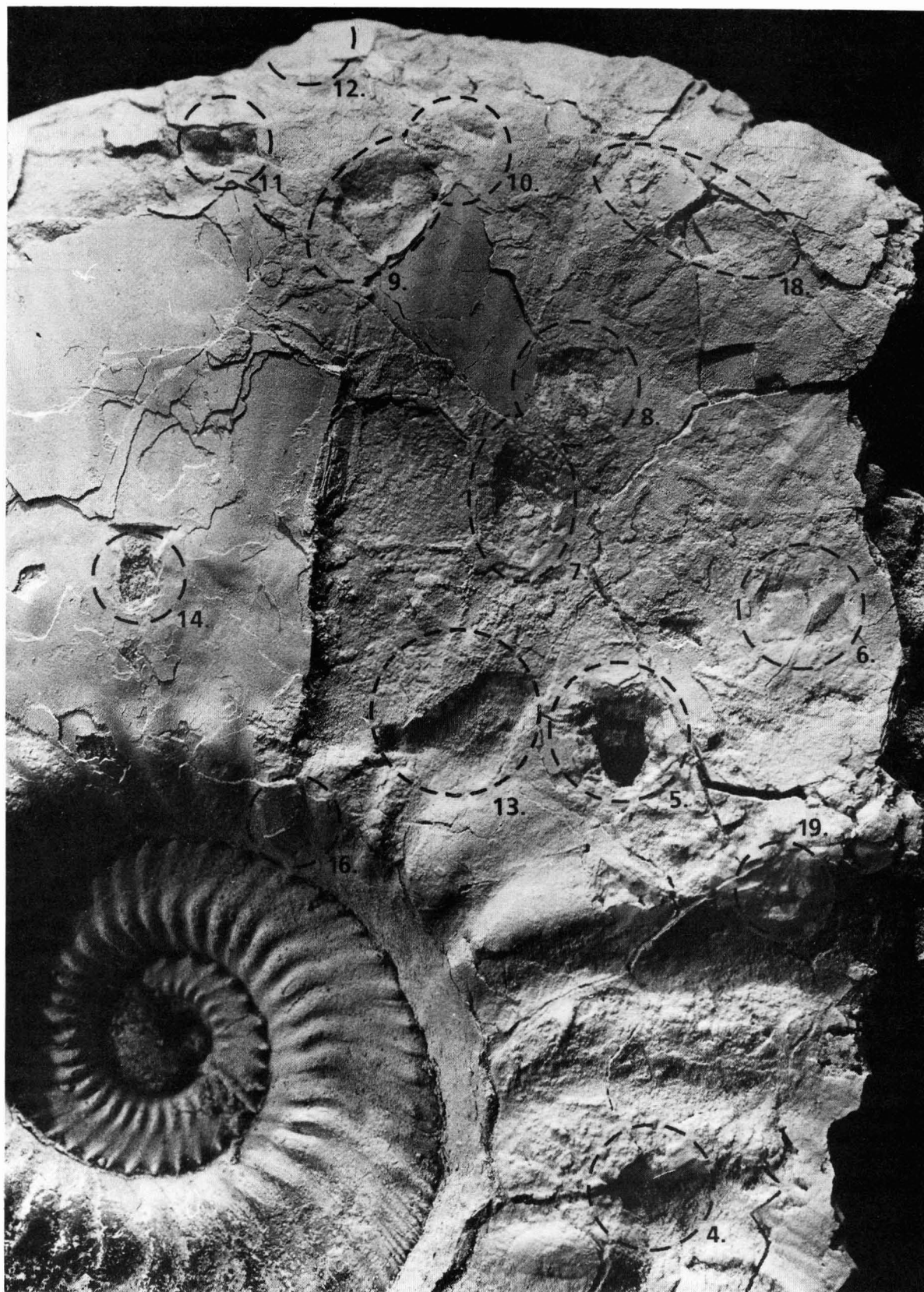
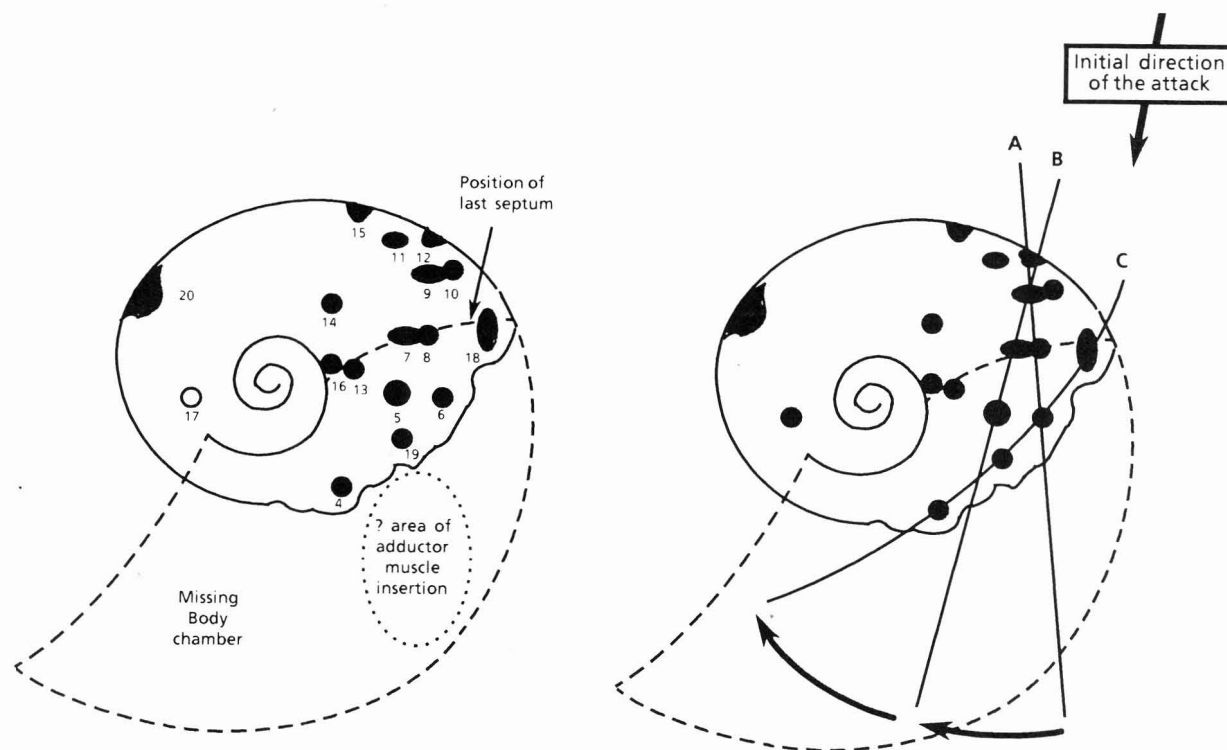


Plate 2. *Kosmoceras* (*Gulielmiceras*) *gulielmi* (J. Sowerby), BM(NH) C. 933414, Middle Oxford Clay (Middle Jurassic, Callovian), Newton Longville, Bletchley SP 866323, detail $\times 3.5$.

Plesiosaur teeth tend to be long, incurved and have rounded tips (Brown 1981). Plesiosaur teeth are stouter and possess wide bases (Tarlo 1960:183). Both could have produced the pattern of indentations present on the *Kosmoceras*. Marine crocodiles also possess robust conical teeth with rounded tips. Lehmann (1981 fig. 99), in a reconstruction of an Early Jurassic sea, shows the mesosuchid crocodile *Mystriosaurus* attacking a *Phylloceras*. It is interesting that the angle of attack depicted is also from above and behind, although this reconstruction is not supported by fossil evidence. Martill (1986) describes cephalopod hooks, most probably from a belemnite, in the stomach of marine crocodile from the Lower Oxford Clay.



Text-fig. 4. Position of the punctures relative to the body chamber and presumed direction of attack.

A single genus of ichthyosaur, *Opthalmosaurus*, is known from the Oxford Clay although presence of other species of ichthyosaur cannot be discounted. Its dentition is reduced (Andrews 1910) but possibly capable of causing indentations. Jurassic ichthyosaurs with preserved gastric contents are relatively well known (Pollard 1968); ammonite remains however, do not feature in these. These may be because belemnites and fish were the preferred prey, or because after a short period of digestion no recognisable ammonite remains would be discernible.

Despite having an excellent set of tooth impressions, Kauffman & Kesling were unable to determine the species of mosasaur that was responsible for the damage to the *Placentiaceras* shell. We are in an less fortunate situation in not having distinct prints of both jaw rami. Mapes & Hanson (1984) were able to deduce the identity of their Carboniferous predator because sharks were the only large predators and by eliminating those with unsuitable dentitions. In our case a wide range of marine reptiles, plesiosaurs, pliosaurs, crocodiles and ichthyosaurs, all could have caused the indentations seen.

CONCLUSIONS

The rarity of predated ammonites is difficult to explain. The scarcity of suitable sediments to preserve uncrushed specimens is not a complete answer. It is possible, that in most cases the victim was eaten whole or the shell crushed to unrecognisable pieces. The identity of the predator is impossible to establish with certainty, other than to suggest that it was probably a marine reptile with stout rounded-tipped teeth. This short note is an attempt to stimulate interest in this problem and to bring to light similar occurrences.

ACKNOWLEDGMENTS

The authors are happy to thank the following people for assistance in the preparation of this paper. Dr A. Milner, Mr C. Walker, Dr C. Patterson and Dr P. Forey for discussions regarding possible reptilian and fish predators. Dr M. Howarth offered encouragement and identified the ammonite.

The authors would also like to thank the London Brick Company Plc. for access to the Bletchley Brickpit.

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