

UNDESCRIBED MAMMOTH (*Mammuthus*) TEETH FROM GEORGES BANK AND NOVA SCOTIA

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Ten molar teeth of mammoths are described, nine of them dredged by fishermen from the northeastern corner of Georges Bank while the tenth was in gravel from near James River, Nova Scotia, although found at St. Francis Xavier University. Measurements and morphological features are discussed and the molars are referred to woolly mammoth (*Mammuthus primigenius*) although a few specimens are lower crowned than is usual and may represent a local variant.

On décrit dix dents molaires de mammoths, dont neuf ont été dragués par des pêcheurs au coin nord-est du Banc Georges tandis que le dixième a été trouvé dans du gravier près de James River, Nouvelle-Ecosse et a été découvert plus tard à l'Université St. Francois Xavier. On discute des mesures et des traits morphologiques, et ces molaires ont été placées dans le groupe du mammoth laineux (*Mammuthus primigenius*), bien que quelques spécimens démontrent des couronnes moins élevées que l'ordinaire, et représentent peut-être une variante locale.

Introduction

In 1967, Whitmore *et al.* discussed the occurrence of elephant teeth on the Atlantic continental shelf, including four mastodon and three mammoth teeth from Georges Bank; two of these specimens were illustrated in that paper (Fig 1.1, 1.2). Nova Scotia scallop fishermen operate mainly on the northeastern edge of Georges Bank and it appears that fossils of various types are found particularly near an elongate bar running SE from 42°00'N 67°30'W to 41°53'N 67°20'W, known as "The Rip". Ten more specimens have come to our attention and probably many more are in private hands. Details of the discoveries are often scanty or lacking but the available background data are set out in Table I.

Description

There are two mammoth teeth in the collections of the Nova Scotia Museum (#1 and #2 in Table I). Specimen #1 is the front half of the left lower molar, possibly M₁ or M₂. There are 8 lamellae preserved, all in wear, and the last plate is somewhat shattered. The whole specimen has been rolled and abraded as if it had been part of a gravel; the roots are completely gone. The enamel borders of the plates are generally parallel and the enamel is thin and crimped. Measurements are given in Table II.

Specimen #2 was collected by Eugene d'Entremont in 1963 from Georges Bank in his ship "Acadian Pal". It is the back half of an upper molar, probably RM³ (Fig 1 A,B). There are 9 plates preserved as well as a terminal half plate, which is broken. The front

Table I Some data on mammoth teeth from Georges Bank and Nova Scotia

No.	Collection	Position	Year	Collector/Vessel
1.	NSM 984 GF 10.1	Unknown	Unknown	
2.	NSM 984 GF 23.1	41°55'N, 67°30'W	1963	Eugene d'Entremont/ "Acadian Pal"
3.	NMC 47728	Georges Bank	1967	Unknown (Dr. L.P.Chiasson)
4.	Sollows "A"	c42°00'N, 67°30'W	c1970	Unknown (J.D.Sollows)
5.	Milton School Yarmouth "B"	ditto	c1970	Unknown (J.D.Sollows)
6.	YCM "C"	ditto	c1970	Unknown (J.D.Sollows)
7.	Huntsman Aquarium	41°43.5'N, 67°9.3'W	1977	/"Sharon and Dawn II"
8.	James River	James River, N.S. gravel pit	1980	Bishop Malcolm MacEachern
9.	Jeddry	41°20.4'N, 66°20.1'W	1981	Victor Jeddry
10.	YCM NS 92.6	Georges Bank	1985	Blair Doucet /"Lady Denise"

NSM = Nova Scotia Museum, Halifax; NMC = Canadian Museum of Nature, Ottawa;
YCM = Yarmouth County Museum, Yarmouth; c = approximately.

three plates are in full wear and the remainder lightly worn to show small enamel islands representing 5 digitations in the next three plates, 4 in the last two. The enamel is thin and crimped. Measurements are given in Table II.

In the mid-1960s, members of the Biological Research Station at St. Andrews, New Brunswick, were examining strange catches (including a Miocene shark tooth, an unidentified crab, and a *Perna* shell) brought in by Georges Bank scallop fishermen. They also received a fine but fragile mammoth molar (#3) from Dr L.P. Chiasson of the Biology Department at St. Francis Xavier University, Antigonish; this specimen is now in the Canadian Museum of Nature in Ottawa (NMC 47728). The molar had been impregnated with beeswax to preserve it, and may be the most complete upper third molar of a mammoth to come from the Atlantic continental shelf. It has 18 plates preserved but with one or two broken away at the talon; the 4th plate is badly shattered and part was lost. Six of the plates are in wear. The unworn plates show 5-8 digitations and the worn anterior plates produce rather narrow irregular islands, but plates #2 and #3 show three separate islands — a median and two laterals. The enamel is thin and finely crimped. The greatest length perpendicular to the plates is 215 mm and when complete the tooth may have measured 225-230 mm. The greatest breadth of 81 mm is at the 8th plate, while the maximum height is 155 mm; this gives a hypsodonty index

Table II Measurements on mammoth teeth from Georges Bank and Nova Scotia

No.	Collection	Tooth	P	L	W mm	H mm	Et mm	LF	100 H/W
1.	NSM 984 GF 10.1	LM ₂ ?	+8+	87	54.9	81	1.3-1.5	9	158
2.	NSM 984 GF 23.1	RM ³	+9x	127.5	89	104	1.4-1.7	8	117
3.	NMC 47728	RM ³	18+	215+	81	155	1.5-1.9	8.5	191
4.	Sollows "A"	RM ₂	+14	186+	69	80+	1.5-2.0	7.5	116+
5.	Milton School Yarmouth "B"	LM ₂	+14	145+	68	56+ (90e)	1.5-2.0	10	132e
6.	YCM "C"	RM ₃	+18x	206+	61.5	73+ (95e)	1.5-1.8	9	154e
7.	Huntsman Aquarium	RM ₃	x17x	185	61.5	104	1.6-2.1	10	169
8.	James River	RM ²	+10	143+	57	76+	2.0	8	133+
9.	Jeddry	RM ₃	+16+	271+	56.5	79+	1.5-1.9	6.5	140+
10.	YCM NS 92.6	LM ³	+15x	201e	77.5	94+ (110e)	1.5-2.0	7.5	121+ (142e)

P = number of plates preserved; L = length normal to plates; W = width of widest lamella; H = height of tallest plate; Et = enamel thickness; LF = lamellar frequency (plates per dm); 100 H/W = hypsodonty index; + = incomplete (before P, anterior lost, after P posterior lost); x = terminal partial plate; e = estimated

(H x 100/W) of 191, which is greater than that of any other tooth from the shelf described by Whitmore *et al.* (1967) or those described here (Table II). It is thus more like the typical *Mammuthus primigenius* than many of the other specimens from the continental shelf. However, one of the best preserved specimens (USNM 23569) dredged up off Cape Henry, Virginia (36°51.5'N, 75°02'W) and reported by Whitmore *et al.* (1967) was later referred to a woolly mammoth (Harington and Ashworth, 1986).

One of the authors (JDS) lived in Yarmouth and, while a student at Dalhousie University, assembled material available locally and collected near The Rip, which he described for a class assignment. The collection included some derived Cretaceous or older specimens, numbers of Miocene and Pleistocene molluscs, teeth of the Miocene shark *Carcharodon*, walrus tusks and some elephant remains. He reported that in 1966 an 8-foot long rib was dredged up but broke into several pieces en route from Georges Bank to Yarmouth. There was one well-preserved tooth of an American mastodon, *Mammot americanum*, 165 mm in length and 89 mm in width, bearing five pairs of cusps. Three mammoths were represented, all by lower molars. Of those three, Specimen "A" (#4) is a damaged RM₂ in full wear with 14 ridge plates preserved, part of the front probably already lost through natural wear but the hindmost plates are still in an early stage of attrition. The tooth was largely covered by a film of bituminous material, possibly bunker oil. Specimen "B" (#5) is now in the collections of Milton

Elementary School in Yarmouth (Fig 1 C,D). The tooth is probably an LM₂, also with 14+ ridge plates but the crown is more worn than "A" and had already lost part of the anterior plates through natural wear of the crown. The original height was probably close to 90 mm. The anterior four plates are broken up into residual elongate enamel islands. Specimen "C" (#6) is now in the Yarmouth County Museum. It is an RM₃ with 18+ ridge plates, the talon being broken and at least 2 plates lost. The crown is widest at the 9th lamella and tapers towards the back to one quarter of the width of lamella #9 (Fig 1 E,F). The enamel is moderately wrinkled in the anterior half of the crown but less so in the back half. Plate #13 shows signs of separation into two major enamel islands, plates #14, 15, 16 and 18 exhibit 4 islets but plate #17 has five rounded digitations. In all these specimens the plates are compressed and parallel sided, although #2 shows some tendency for a median expansion in the more worn lamellae. The original height of the crown was estimated to be close to 95 mm. Dimensions are shown in Table II.

An excellent RM₃ (#7) is on display at the Huntsman Aquarium in St. Andrews, New Brunswick. It was found by the scallop dragger "Sharon and Dawn II" in July 1977 at a depth of approximately 35 fathoms (70 m) at the position shown in Table I. It was broken in transit but has been beautifully repaired. There is a small anterior "half" plate, 17 complete lamellae and a small talon, but nothing appears to have been lost anteriorly (Fig 2 A, B). The first 9 plates are in full wear across the crown, plates #10-13 show a central enamel island separated from the lateral islands but the last four plates show the 4 or 5 digitations that merge with wear into the central enamel ring. The enamel is crimped. The height of the unworn 14th plate is 104.3 mm and the maximum width of 61.5 mm is at the 6th plate, giving a hypsodonty index of 169 which is greater than that of any of the other lower molars from the shelf. There are 10 plates to a 100 mm length and these measurements and the morphology are well within the range of variation for the woolly mammoth, *Mammuthus primigenius*.

Specimen #8 was not recovered from the continental shelf but was found in 1980 by the late Bishop Malcolm MacEachern on the playing fields of St. Francis Xavier University, Antigonish, in gravel fill brought from a pit near James River, Nova Scotia. A mastodon molar was also found in this gravel. Although mastodon remains have been discovered at several sites in Nova Scotia, this is the only mammoth tooth to have been recovered on land. Investigation by Professor W.S Shaw of the Department of Geology at St Francis Xavier University suggested that the teeth were indeed brought in from gravel pits near James River and were not discards from some fisherman's collection. As might be expected, specimen #8 is somewhat damaged, especially at the side of the plates, and part of the front has been lost. According to the degree of freshness of the breaks, the sides and tips of the roots were broken off early, and fragments from the anterior and posterior were lost more recently, perhaps in transport and deposition at the site. The tooth is an upper molar (probably RM²), in moderately advanced wear. Ten of the plates remain but several have been lost from the front through natural attrition and damage. Dimensions are given in Table II and the specimen is shown in Fig 2 C,D.

Another mammoth tooth (#9) was brought up in a scallop dredge on Georges Bank in July 1981 by Victor Jeddry of Meteghan, Nova Scotia, and is in his possession. It is an RM₃ with 16+ plates preserved (#9), and the lamellar frequency is only 6.5 plates in 100 mm. The talon is lost and it is also possible that one or more plates had been shed anteriorly. The tooth belonged to a relatively old individual as the anterior three plates were worn to a tract of dentine with residual scraps of enamel on the right (buccal) side. The last two preserved plates show only rings of enamel, not yet united

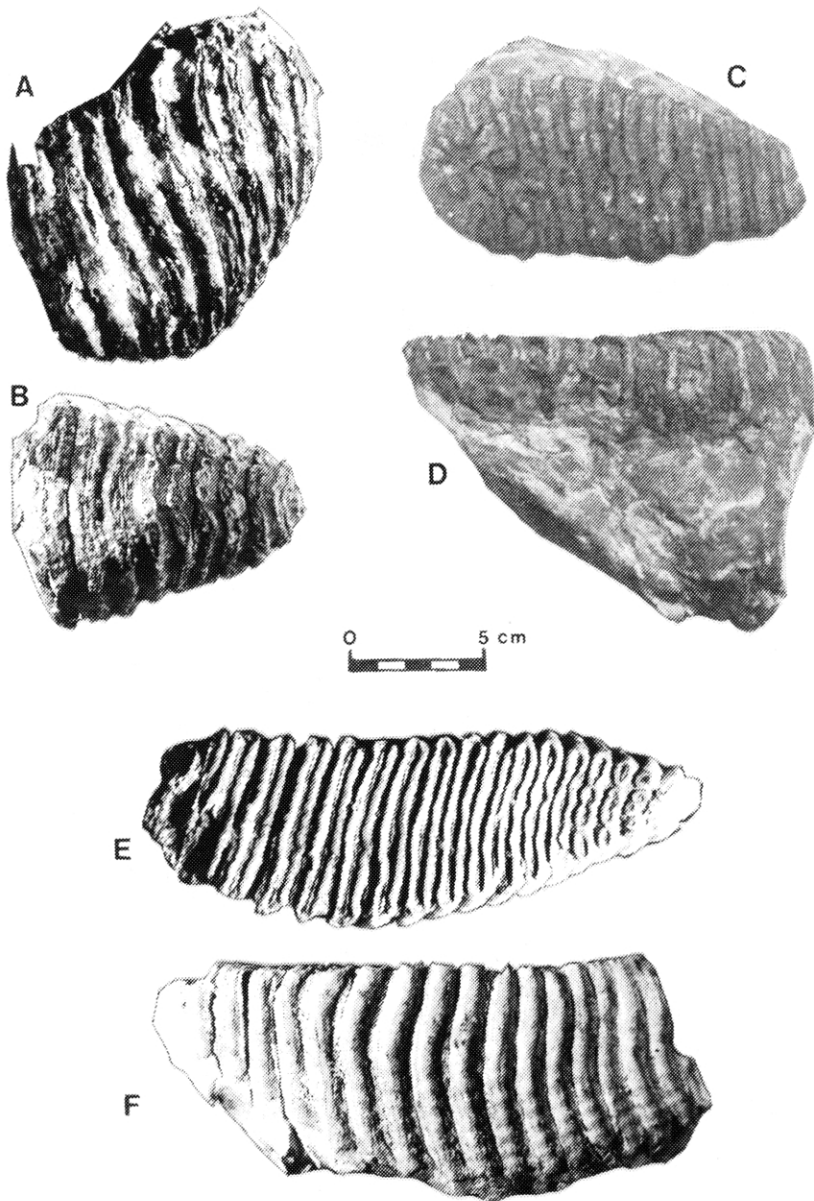


Fig 1

A, B: Back half of right upper third molar, NSM 984 GF 23.1 (#2), in the Nova Scotia Museum collections, seen in inner lateral and occlusal views. C, D: Well worn left lower second molar (Milton School "B"; #5) seen in occlusal and outer lateral views. E, F: Right lower third molar (YCM "C"; #6) seen in occlusal and inner lateral views. One third natural size.

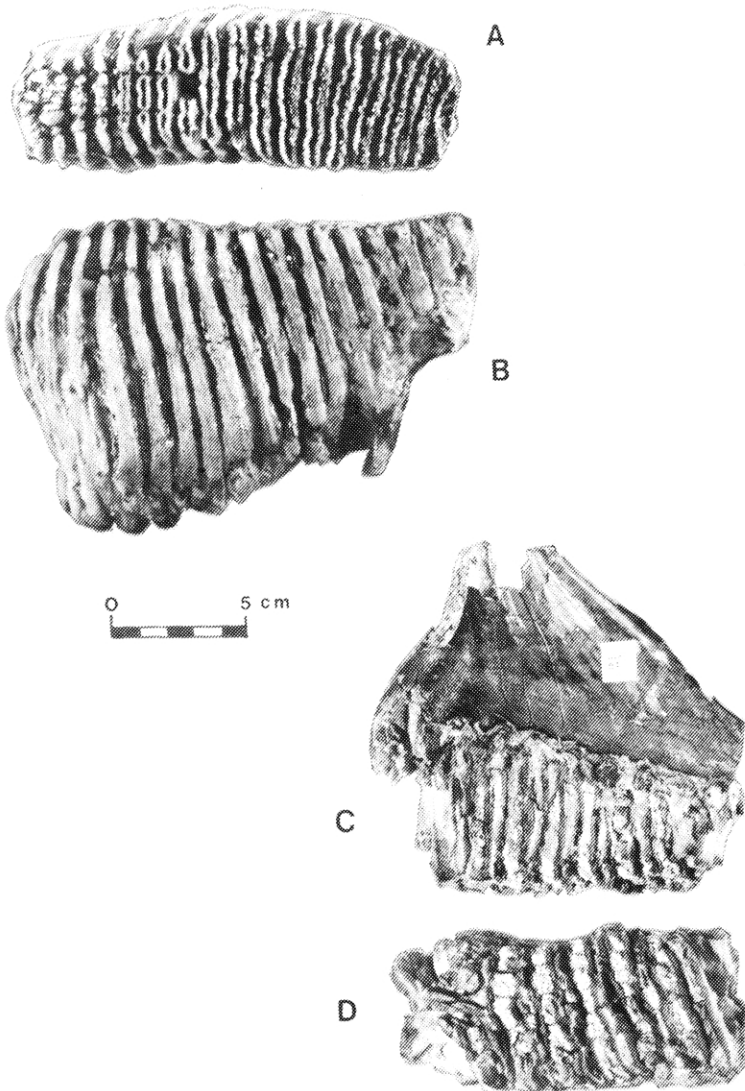


Fig 2

A, B: Complete right lower third molar in the Huntsman Aquarium collections (#7), seen in occlusal and outer lateral views. C, D: Right upper second molar (#8) found at St Francis Xavier University, Antigonish, in gravel brought from James River, Nova Scotia, seen in outer lateral and occlusal views. This is, so far, the only woolly mammoth tooth found on the Nova Scotian mainland. One third natural size.

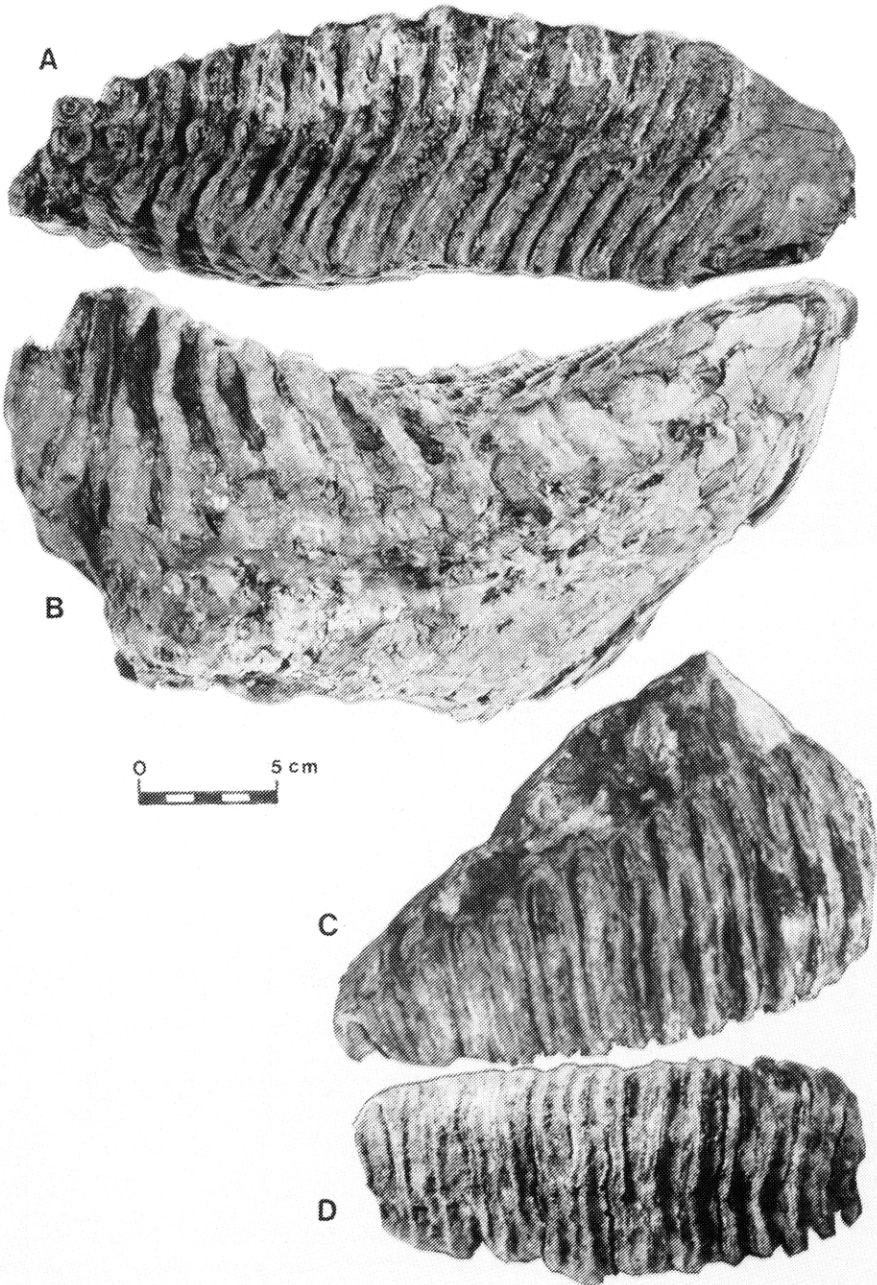


Fig 3 A, B: Left upper third molar, YCM NS 92.6 (#10), in the Yarmouth County Museum collections, seen in outer lateral and occlusal views. C, D: Right lower third molar, found by Victor Jeddry (#9) seen in outer lateral and occlusal views. Note abnormal asymmetrical concave wear surface. One third natural size.

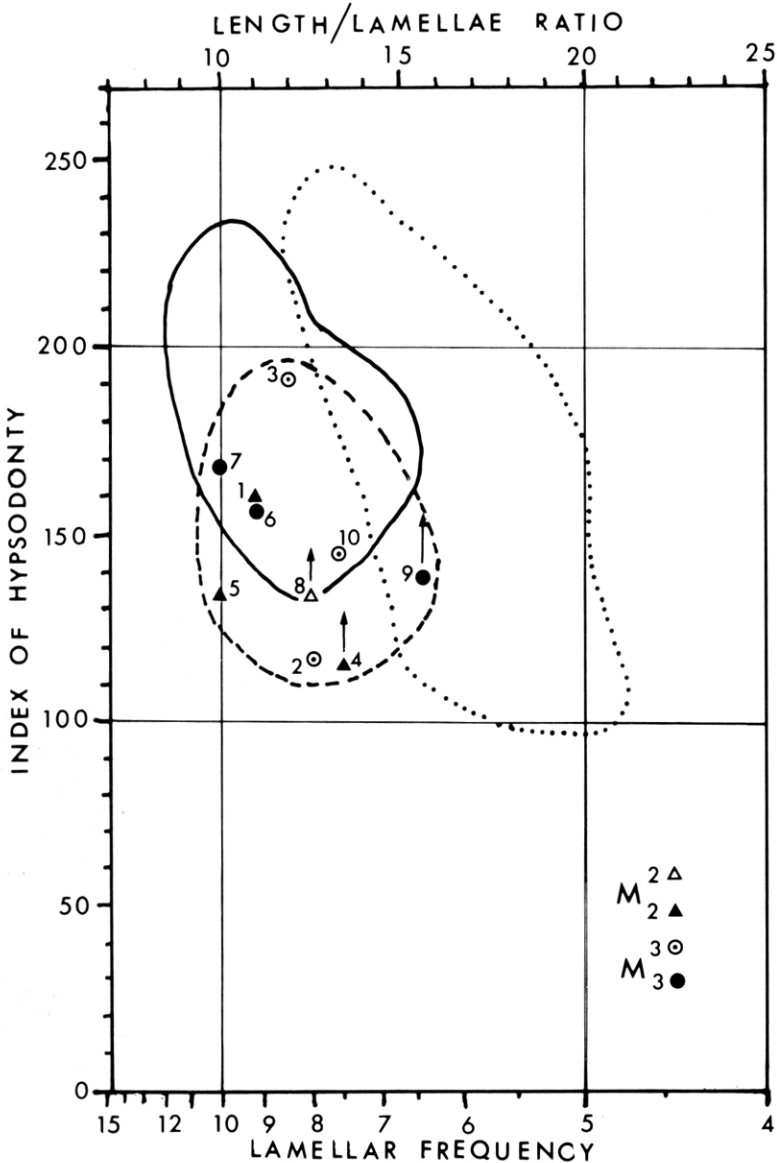


Fig 4

Diagram showing the relationship between the hypsodonty index and the lamellar frequency for the ten teeth described in this paper. The dashed line encloses the plots for the ten specimens considered here. The solid line shows the observed range of variation for upper and lower second and third molars of Holarctic *Mammuthus primigenius* (mainly from data in Maglio, 1973) while the dotted line encloses the range of variation found in North American *Mammuthus columbi* (after Whitmore *et al.* 1967). The arrows above #4, #8 and #9 indicate that the hypsodonty index is a minimum value and was probably greater.

into the characteristic narrow islands. The wear is abnormal, for the left (lingual) side was hollowed below the usual planar surface and the surface also cuts obliquely across the lamellae (Fig 3 A,B). The enamel is crimped. The dimensions are given in Table II.

The tenth specimen to be included here was found by Mr. Blair Doucet of Yarmouth about 1985 on the scallop dragger "Lady Denise", and is now in the Yarmouth County Museum (YCM NS 92.6). It is a fairly heavily worn LM³ with part of the root system, of which the anterior portion has been broken away recently. Fifteen plates remain but two or three additional anterior plates were present originally, and the posterior terminal plate is lost (Fig 3 C,D). Measurements are given in Table II.

Discussion

The mammoth teeth available to Whitmore *et al.* (1967) resembled those of the woolly mammoth in the multiplicity of plates and thin enamel but appeared to be lower crowned. They also resembled the finer-structured teeth ascribed to *Mammuthus jeffersoni*, regarded by Maglio (1973) as a northern variant of *M. columbi* in which diet has led to a convergent resemblance to the woolly mammoth. *M. columbi* is the characteristic elephant of the Sangamon and the Wisconsinan in southern North America and the lamellae are typically thicker than those of *M. primigenius* i.e. the lamellar frequency is lower; the enamel is also generally thicker.

Although morphological characters are clearly of prime importance, crown height and plate thickness are valuable statistics. Mean plate thickness can be measured as the length/lamellae ratio (crown length/number of plates) or is more usually indicated by its reciprocal, the lamellar frequency (plates per dm). A plot of the hypsodonty index against the lamellar frequency is a useful aid in diagnosis. Fig 4 shows the relative positions of the ten teeth described here in relation to the observed ranges for the upper and lower second and third molars of *M. primigenius* and *M. columbi*. All these specimens have thinner lamellae than in typical *M. columbi* and six of them lie within the observed range for *M. primigenius*. However, three good specimens (#2,4,5) have hypsodonty indexes a little below the range recorded for *M. primigenius*, adding to the impressions of Whitmore *et al.* (1967) that some of the shelf elephants may be a localized variant. The Jeddry tooth (#9) has fewer plates per 100 mm than the other specimens and is within the range for *M. columbi*; however, if the height of the unworn teeth was about 95 mm, which is probable, the hypsodonty index would lie near the *M. primigenius* field.

Another characteristic that has been employed to differentiate between these rather similar species is the thickness of the enamel and the extent of folding on the contact surface between the enamel and the cementum (Churcher 1986; Nielsen, Churcher and Lammers, 1988). In the specimens from Georges Bank the enamel is generally thin (1.4 - 2.0 mm) and moderately to finely plicate. When coupled with the lamellar frequency, all the specimens lie within the range for *M. primigenius* but some of them fall in an area of overlap between *M. primigenius* and *M. columbi*. However, at least two (#5,7) fall outside the range for *M. columbi*. As the ages of the deposits from which the teeth were derived are not certainly known, it is always possible that different ages are represented. On balance, all should probably be referred to *M. primigenius* although perhaps some individuals represent a regional or local variety. Good cranial material is needed to resolve the problem, but it is unlikely to come from the shelf. It is worth considering the teeth mentioned here as representing a partly isolated northeasternmost population of woolly mammoths occupying a tundra-like habitat south of the Wisconsinan ice sheets (Harington and Ashworth, 1986, Fig 3).

Acknowledgements

We thank the people who recovered the specimens we examined, the institutions where they are now preserved, J. McElman and R. Chandler for providing photographs and data, and C. Kennedy for photographs. E. J. Ruff, R. Grantham and Dr M. Blouw generously donated specimens or allowed us to study material in their collections. G. R. Fitzgerald and K. Shepherd conserved several of the teeth. We are indebted to Dr D. R. Grant for obtaining background data on the James River tooth.

References

- Churcher, C.S.** 1986. A mammoth measure of time: Molar compression in *Mammuthus* from the Old Crow Basin, Yukon Territory, Canada. *Current Research in the Pleistocene*, 3: 61-64.
- Harington, C.R.** and **Ashworth, A.C.** 1986. A mammoth (*Mammuthus primigenius*) tooth from late Wisconsin deposits near Embden, North Dakota, and comments on the distribution of woolly mammoths south of the Wisconsin ice sheets. *Canadian Journal of Earth Sciences*, 23: 908-918.
- Maglio, V.J.** 1973. Origin and evolution of the Elephantidae. *Transactions of the American Philosophical Society*, 63: 1-149.
- Nielsen, E., Churcher, C.S.** and **Lammers, G.E.** 1988. A woolly mammoth (Proboscidea, *Mammuthus primigenius*) molar from the Hudson Bay Lowland of Manitoba. *Canadian Journal of Earth Sciences*, 25: 933-938.
- Whitmore, F.C., Emery, K.O., Cooke, H.B.S.** and **Swift, D.J.P.** 1967. Elephant teeth from the Atlantic Continental Shelf. *Science*, 156:1477-1481.

(Received 14, December 1992)